A RETROSPECTIVE AND PROSPECTIVE ANALYSIS OF FUNCTIONAL OUTCOME OF REVISION LUMBAR SURGERY FOR FAILED BACK SURGERY SYNDROME

Dissertation submitted to

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ORTHOPAEDIC SURGERY

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CERTIFICATE

This is to certify that this dissertation titled **"A Retrospective And Prospective Analysis of Functional Outcome of Revision Lumbar Surgery for Failed Back Surgery Syndrome"** is a bonafide record of work done by **DR.R.NEELAKANNAN,** during the period of his Post graduate study from May 2012 to September 2014 under guidance and supervision in the INSTITUTE OF ORTHOPAEDICS AND TRAUMATOLOGY, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-600003, in partial fulfillment of the requirement for **M.S.ORTHOPAEDIC SURGERY** degree Examination of The Tamilnadu Dr. M.G.R. Medical University to be held in April 2015.

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DECLARATION

I declare that the dissertation entitled **"A Retrospective And Prospective Analysis Of Functional Outcome Of Revision Lumbar Surgery for Failed Back Surgery Syndrome."** Submitted by me for the degree of M.S is the record work carried out by me during the period of **May 2012 to September 2014** under the guidance of **Prof**.**Nalli.R.Uvaraj.M.S.Ortho.,D.Ortho.,**. Professor of Orthopaedics, Institute of Orthopaedics and Traumatology, Madras MedicalCollege, Chennai. This dissertation is submitted to The Tamilnadu Dr.M.G.R. Medical University, Chennai, in partial fulfillment of the University regulations for the award of degree of M.S.ORTHOPAEDICS (BRANCH-II) examination to be held in April 2015.

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ABSTRACT

Introduction:

About 40% of patients who got operated for the low back pain came with persistent or recurrent pain following the surgery. The causes of pain are recurrent disc prolapse, post laminectomy instability, instrumentation failure, pseudoarthroses, Adjacent level degeneration, flat back syndrome. In this study we evaluate the functional outcome of these patients after the revision surgery.

Aim and Objective:

To retrospectively and prospectively study the functional outcome of revision lumbar surgery for failed back surgery syndrome.

Materials and methods:

This study was conducted among 20 patients who came with recurrent pain after the index surgery at Rajiv Gandhi Govt. General hospital, Chennai - 03. Our study had a female predominance with a mean age of 41.1 yrs. The patients were evaluated clinically for pain and disability by the VAS and ODI score respectively. Objective evaluation also done by the neurological examination. Routine radiographs,CT scans and MRI are taken to diagnose the cause of recurrent pain. The evaluated patients were operated, targeting the cause of pain. Spinal fusion was done in 50% of patients. Post operatively patients were evaluated with ODI,VAS score.

Observations and Results:

The major cause of the recurrent in this study is recurrent disc(40%),post laminectomy instability(35%), instrumentation failure(25%). The mean pain free interval is 30.95 months. The mean number of previous surgery is 1.13. The overall success rate in our study was 60%. The patients with pain free interval more than 6 months had better outcome than the patients with PFI less than 6months. Patients operated for instability had better outcome than other patients.

Discussion:

The success following the revision surgery depends on the proper preoperative evaluation,precise diagnosis, pain free interval,number of previous surgeries, age, sex and the experience of the operating surgeon. The overall success rate was 60%. The patients with the instability had good outcome than the other group patients which is comparable to other studies. Patients with PFI > 6 months have good outcome than with patients < than 6 months which is statistically significant. Younger patients had better outcome which may be due to good post op rehabilitation. Outcome of the patients treated with fusion and without fusion had similar results this is because the short term follow up.

Conclusion:

Proper preoperative evaluation, diagnosing the specific pathology and targetting the pathology is of paramount importance in the management of failed back surgery syndrome. Good experience and expertise in meticulous dissection prevents complications like dural tears and infections.Spinal fusion is mandatory in cases of postlaminectomy instability, and recurrent disc prolapse with demonstrable instability.For the successful outcome of the revision surgery for failed back syndrome spinal fusion is compelling. However a long term follow up and a larger sample study is needed to further validate our findings**.**

Key words:

Failed back surgery syndrome, Spinal fusion, ODI score, VAS score, pain free interval.

TABLE OF CONTENTS

INTRODUCTION

About 40% of patients undergoing lumbar surgeries for low back pain come with significant amount of pain after the surgery[14].

Among these patients many fall under the entity called Failed back syndrome.

Definition of Failed Back Surgery Syndrome:

This is defined as the persistent or recurrent low back pain after one or more than one lumbar surgeries[14]. Its incidence is 15%. Various causes of Failed back syndrome are Recurrent disc herniations, spinal stenosis, post laminectomy instability, flat back syndrome, and pseudoarthrosis.

These patients are divided in to two basic groups in whom,

1. Surgery is never indicated
2. Surgery is indicated but inadequately performed.

These substantial portion of patients contribute a big expenditure to the society because of the functional morbidity.

Appropriate patient selection is an important factor in the outcome after spinal surgery.

The common causes for the recurrent pain are,

Mechanical causes:

1. Recurrent Disc
2. Post laminectomy Instability
3. Implant failure
4. Spinal canal stenosis
5. Flat back syndrome
6. Adjacent level degeneration

Non- Mechanical Causes:

1. Arachnoiditis.
2. Epidural scar tissue formation.

The success rate following revision surgeries are usually between 12-82%. This is mainly based on the cause of revision lumbar surgery.It has been observed that as the follow up period increases the success rate decreases and as the number of surgeries increases the success rate decreases.

The functional outcome of the revision surgery depends on the cause of failed back syndrome , number of revision surgeries, type of surgery whether fusion or non-fusion, and finally the experience of the surgeon.

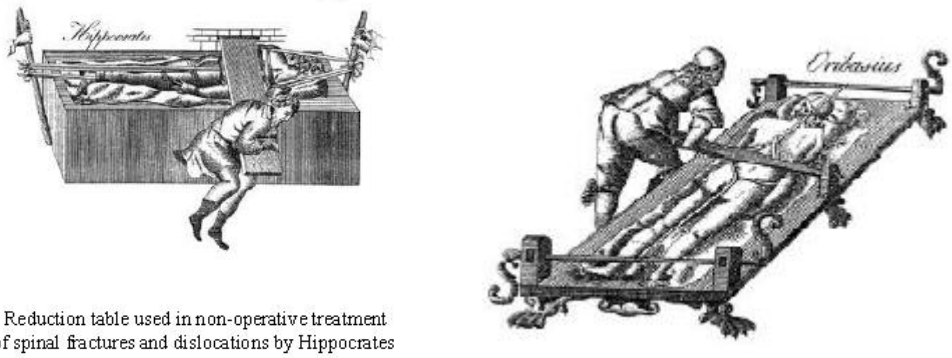
AIM AND OBJECTIVE

To Retrospectively and Prospectively study the clinical and functional outcome of revision lumbar surgery in twenty failed back surgery syndrome cases at Rajiv Gandhi Govt. General hospital from December 2013 to september 2014.

HISTORY

History of treatment of spinal fractures:

The history of treating the spinal fractures were written in the Smith papyrus rolls about 1500 B.C. Hippocrates and Oribasius used special tables for reducing the thoraco- lumbar fractures(Fig: 1)



Reduction table used in non-operative treatment of spinal fractures and dislocations by Hippocrates

Fig: 1

The History of laminectomy fall back to about 7th century when Paul of Aegina suggested laminectomy for the fracture of vertebra. But the documented evidence of laminectomy was in 1886 by MacEwen.

The credit of spinal instrumentation goes to Hadra of Galueston [5]. where he stabilised a cervical spine with help of a wire.

In 1911 Hibbs introduced the concept of uninstrumented fusion for the deformed spine but it relied heavily on the prolonged casting [6].

King in 1940 first introduced an internal fixator system in which he placed screws across the facet joints to produce fusion[7,8].

In 1960 Harrington introduced the first successful system which is the gold standard for many years[9]. It has undergone about 47 modifications so far[10].

In 1986 Steffee[11] introduced the trans pedicular fixation of the unstable spine fractures.

Dick et al in 1994 studied the biomechanical properties of the pedicle screw fixation where he found the intermediate screw fixation have a better biomechanical property than the short segmental fixation[12].

REVIEW OF LITERATURE:

As the number of spine surgeries increases, the complications following the surgeries like adjacent level degeneration after a posterior stabilisation, instability following a laminectomy , epidural fibrosis , flat back syndrome produces further pain and disability which requires revision surgeries[13].

The results following the revision lumbar surgeries are guarded , which requires precise techniques and expertise in the field of spine surgery[14].

In 1993 Bernard analysing the factors influencing the outcome of revision lumbar surgery in about 45 patients, registered about 82% of success[15].

In 1990, Bionidi and Greenberg studied about 45 patients with redecompression and fusion for failed back syndrome and reported 47% good and 22 % fair results[16].

Finnegan et al in 1979 studied about 67 patients with revision surgery in a multiply operated patients and reported only 12 good results[17].

Lehman and La Rocca, in 1981 in a review of 36 patients where spinal canal reexploration and fusion was performed reported about 56% success[18] .

Waddell et al in 1979 studied the outcome of repeat lumbar surgery following the industrial injuries , reported that as the follow up period increases the success rate decreases[19].

In 2011 , Richard et al followed up the cases done from 2004 – 2008 for lumbar stenosis,where repeat surgeries with simple or complex arthrodesis was performed. He concluded that as the age increases the possibility of revision decreases. And the complex arthrodesis cases will have high failure rate[20].

Jason et al in 2010 studied clinically and biomechanically that after stabilising the mobile vertebral segment, it will produce additional load on the adjacent vertebra causing severe degeneration.

They stabilised the spine with the pedicle screw based dynamic stabilisation to stabilise the abnormal motion segment and to unload the adjacent disc. The short term follow up shows a better response[21].

W.R.S Hudson et al in 2011, in a randomised control study of 28 patients in whom dynamic stabilisation was done , 22 patients had a good functional outcome[22].

Mulholland et al in 2002 concluded that dynamic stabilisation is safe and very effective in stabilizing the lumbar degenerative diseases[22].

Chak – Bor Wong in 1992 in the study clinical outcomes in 124 patients concluded that to achieve a good result performing spinal fusion, and achieving a solid fusion is mandatory. Targeting the specific pathology of failed back is crucial in attaining satisfactory results[14].

Recurrent Disc herniations:

The Incidence of recurrent disc herniations is 5-11%. About 5-20% of the primary discectomies have unsatisfactory results making this as the major cause of failed back syndrome[23]. It may recur in the same level either ipsilaterally or the contralaterally or it may involve the adjacent level disc[24,25,26,27]. This occurs due to improper decompression, incorrect level of decompression ,the type of annular incision performed during the primary surgery may predispose the disc herniations[28].

Post laminectomy Instability:

Post laminectomy instability results from the inability of the spinal mobile segment to bear physiological loads. Instability mainly causes pain but sometimes also causes deformity and neurological deficit[29]. These patients with pain and instability will be benefitted from interbody fusion.

Spinal Stenosis:

Lumbar canal stenosis is the reduction in canal diameter, nerve canals or neural foramina. The incidence is 1.7-8%[30,31] . The stenosis may be multiple, or may be localised or segmental[20]. In all patients who have experienced multiple lumbar surgeries, canal stenosis may cause leg pain and the back pain. This may be due to the progression of the ongoing degeneration or due to the incomplete decompression or by the overgrowth of the fusion mass. Tension sign is negative. If there is direct evidence of mechanical compression and direct evidence of bony encroachment, then the patients will benefit from decompression surgery. The rate of revision surgery for lumbar stenosis is 5-13 %[32,33]. Diagnosis plays an important role in the prognosis following the revision surgery for stenosis. The results following the revision surgery may be unsatisfactory due to,

1. Wrong diagnosis
2. Improper decompression
3. The instability which is not addressed during the revision.

Wrong diagnosis:

Should be distinguished from the vascular claudication MRI is diagnostic or CT myelogram may be helpful in patients where MRI could not be taken. MRI also distinguishes the scar tissue.

Co-morbidity:

The Medical co morbidities like cardiovascular disorders, Hypertension, bronchial Asthma, rheumatoid arthritis may affect the outcome of the revision surgery. Oldridge et al[34] reported in his study that the mortality rate among the decompression surgery for the average age group of 71 yrs is 0.5 % due to the comorbidities.

Instrumentation failure:

The use of instrumentation for lumbar surgeries has become very popular over past 10 years. The main aim of instrumentation is to maintain and stabilize the spine until spinal fusion occurs. Implant failure occurs when the deforming forces exceed the ability of the implant to stabilize the spine. The presence of implants raises several technical considerations to the revision surgeries like screw breakage, implant loosening and aberrant screw placement. The most common mode of failure is the screw breakage which is usually at the shank – thread junction which is reported at a rate of 0.5 to2.5 %[35,36]. Lonstien

reported that in 12 patients of the 19 screw breakage patients there was pseudoarthrosis[35].

Interbody device failure.:

Interbody cages are the devices used to hold the bone graft until the fusion occurs between the endplates, they can be kept from posterior, lateral or anterior approach[37-41].

Biomechanical studies shows that the intervertebral cages stabilize the motion segments in all directions except in extension[42,43].

Reasons for failure of interbody device:

1. Mainly a failure to select the proper patient for interbody fusion.
2. Poor surgical technique while applying these devices[39].
3. Under sized implant may not produce the stability leading to failure of fusion.
4. Understanding the biomechanics of the motion segment and the interbody device is necessary to achieve the interbody fusion.

There should be a posterior construct in cases of

1. Significant bone rescection
2. Advanced cases of listhesis

3. Multilevel failure

4. Loss of posterior elements like wide laminectomy

5. Fixation of interbody cage in osteoporotic bone

The commom modalities of failure are,

1. Failure of fusion

2. Device loosening

3. Malpositioned device

The device failure perse may not be the reason for revision surgery, only when the device causes any neurological deficit or if there is any vascular compromise, it should be removed and revised because the risks of revising it overweighs the advantage of the revision and if necessary the posterior construct should also be added.

While operating for the malpositioning and migration of the devices there is a risk of neurovascular injury.

The surgical approach to revise the cage should not cause further morbidity but in cases like migration anterior approach may be required.

Moreover if the device revision is planned changing the cage with a larger size cage may not be sufficient it may require an additional posterior construct.

Adjacent level Degeneration:

Otherwise called as the transitional syndrome is defined as the degeneration of the disc above or below the fused segment. The biomechanics of the adjacent level degeneration is explained by the fusion of a mobile spinal segment will lead to the hypermobility of the adjacent segment and increases the stress on these segments producing degeneration. Bio mechanical studies shows that there is increased stress on the adjacent segment[44-51]. Punjabi, in a sheep model showed that the biomechanics of the adjacent discs are altered due to the irregular injury to the involved disc[52].

Non Mechanical causes:

Scar formation and discitis are the two main non mechanical causes of recurrent pain. These conditions respond very poorly following the surgery. Scar formation may be in the dura or outside dura and is known as the epidural fibrosis.

Arachnoiditis: Arachnoiditis is the inflammation of the pia-arachanoid surrounding the spinal cord or cauda equina[53]. This may follow intraoperative dural tear or injection of oil based contrast. Surgery is not an option for arachnoiditis. Non operative techniques like epidural steroid, spinal cord stimulation, bracing and patient training may help[54,55].

Epidural fibrosis:

Epidural Fibrosis may occur around the cauda, nerve roots or outside the dura which produces constriction on the neural elements,and produce post op pain[56].The main confusing part is the recurrent disc which should be differentiated with the help of MRI. Surgical treatment is not indicated for Epidural fibrosis. Rather the condition gets worsened by repeated surgeries.

Dicitis:

An important complication following lumbar surgery, the pathogenesis being direct inoculation of bacteria in to the disc space[57]. Management is strict bed rest, immobilisation with a brace and if the pain does not improve aspiration of the disc space and culture has to be done.Appropriate antibiotics should be started.

ANATOMY OF LUMBAR SPINE

Embryology:

The human spinal column starts developing during the triploblastic stage and ends in the 3rd decade of life. The axial structures are derived from the perichordial mesenchyme. The vertebral body are developed from the loose perichordial disc whereas the dense disc portion forms the original intervertebral disc. Chondroblasts which is present around the perichondial tissues gives rise to the further growth of the vertebral body after the cessation of the growth provided by the loose perichordial tissues. Sclerotomes of the Somites which develops from the dorsal part of the embryo gives rise to the vertebral body (Fig : 2). The cells of the sclerotome is converted into the loose mesenchymal tissues which surrounds the notochord.Extension of this mesenchyme laterally gives rise to the future transverse process and ventrally to give rise to the rib cage.

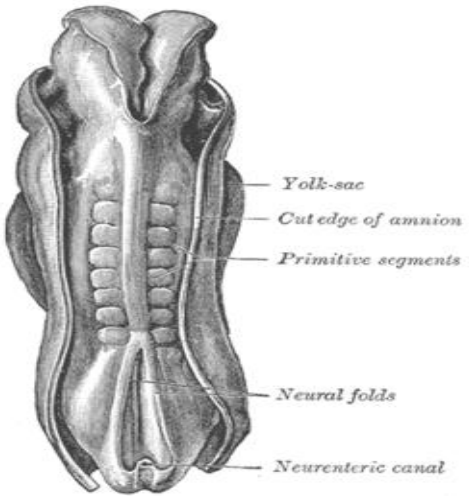


Fig : 2

The mesenchymal cells of the each somite at some areas become condensed , this condensed part is called the perichordial disc. The less condensed part of the adjacent segment fuse to form the vertebral body. Notochord disappears in the region of the vertebral body(Fig : 3). The remnants of the notochord in the intervertebral region forms the nucleus pulposus.

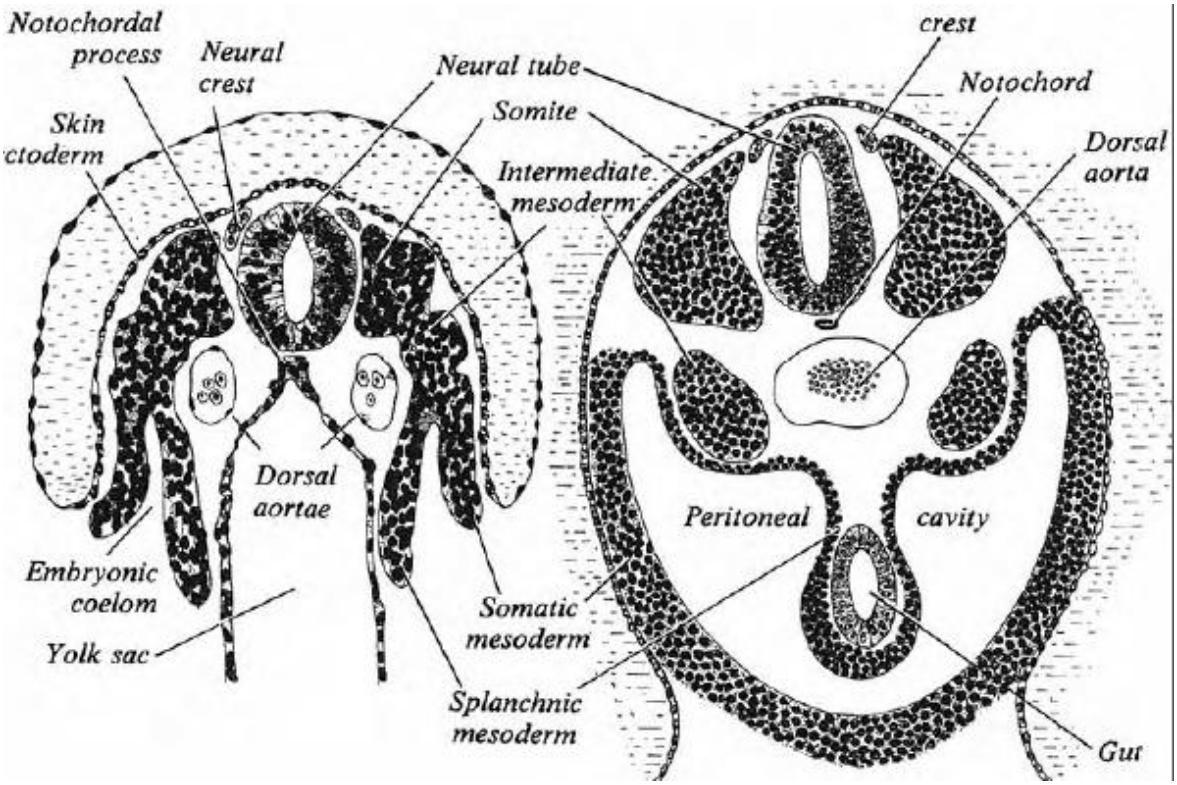


Fig : 3

Therefore the vertebra is developed from the intersegmental portion of the two somites and the intervertebral structure develops from the centre portion of the somite. The transverse process and the rib cage develops from the intersegmental part of the adjoining somite which separates the corresponding muscles developed from the myotomes. Spinal nerves are the segmental structures which emerge in between the vertebra.

The primary ossification centre appears one for the vertebral body and two for the neural arch. The junction between these structures forms the facet joints. Paraaxial mesoderm gives rise to the somites on the 20th day of development. The first pair appears at the rostral end of the notochord , during the next 10 days 38 pairs of somites develops along the cranio caudal direction which called the somite period. Totally 42 – 44 somites develops during this somite period.[1] (Fig : 4)

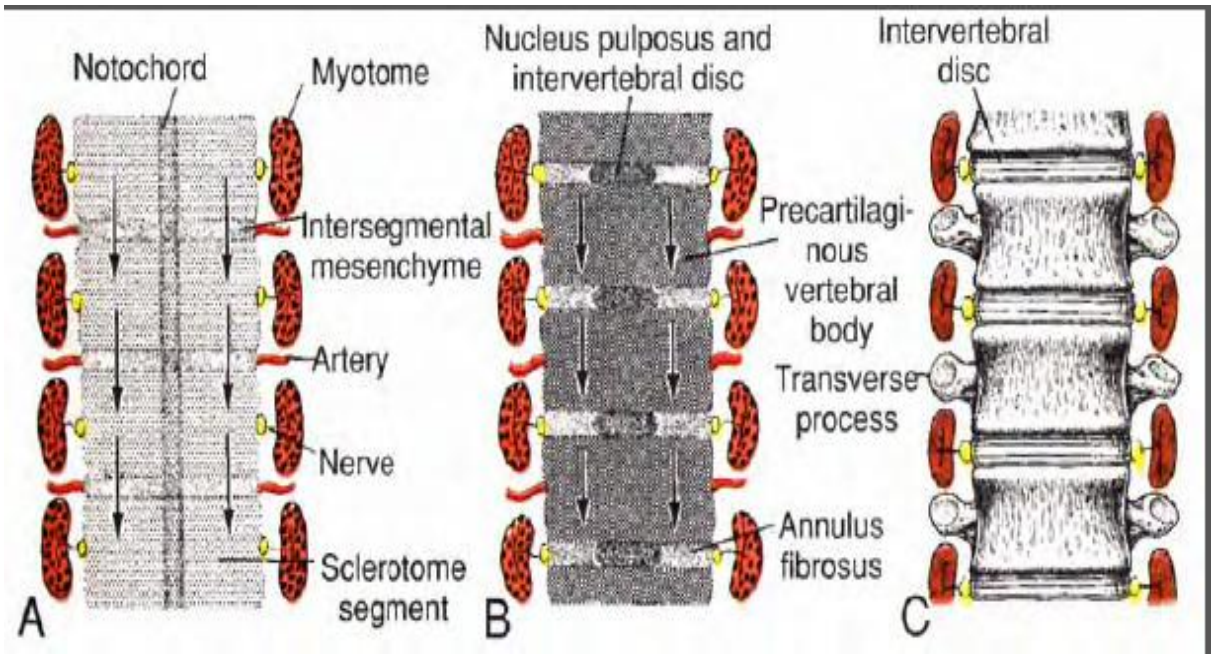


Fig : 4

Ossification of the vertebral arch becomes evident by the 8th week of intra uterine life (Fig : 5). By the 16th week the ossification is well evident. The union of the lamina occurs first in the lumbar region and progresses cranially.

During the 15^{th} – 16^{th} yr the secondary ossification centre appears at the tip of the spinous process and the transverse process which gets fused in the middle of third decade.

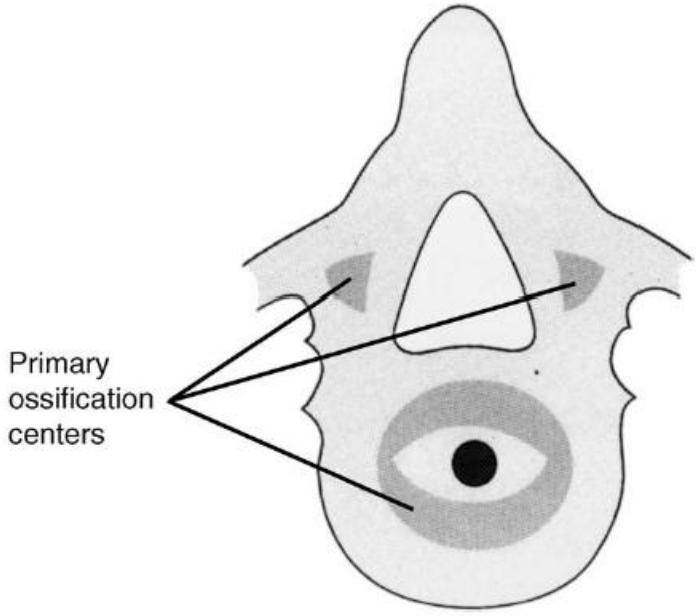


Fig : 5

Sometimes the upper lumbar vertebra may have the extra costal centres, which may give rise to the truly articulated lumbar ribs. The spinal cord develops from the neural tube .(Fig :6)

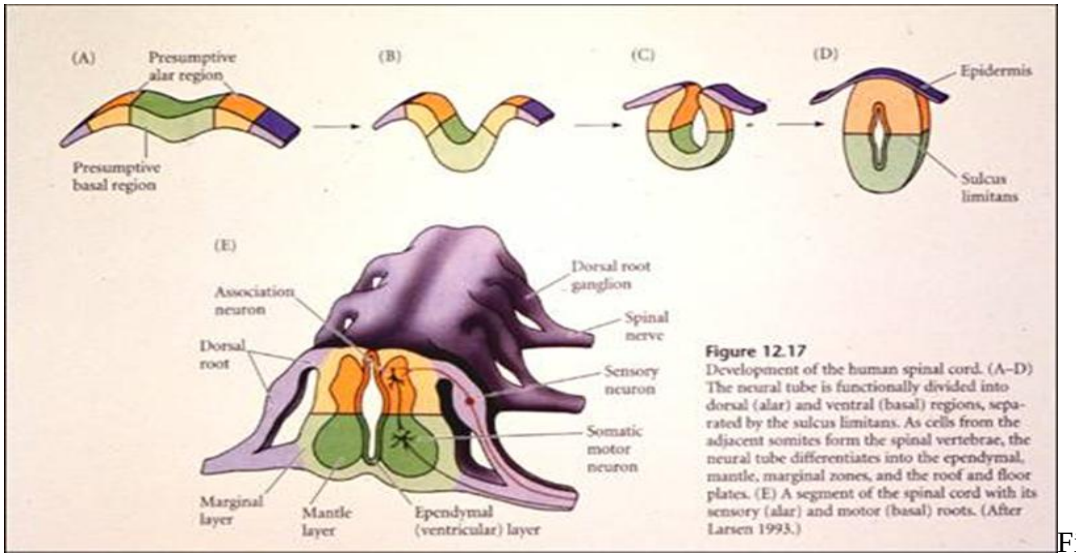


Fig : 6

The lumbar spine:

Thorough knowledge about the anatomy of bony, ligamentous and neurological structures of the spine is important for better understanding and evaluation of the pathophysiology behind the low back ache and assessment of spinal stability after injury.

The human spine consists of (fig : 7)

1. Spinal column

2. Spinal cord

A. SPINAL COLUMN: Classified by Denis in to three [2]

Spinal column consists of

a) Anterior column – Anterior longitudinal ligament,Anterior part of vertebral bodies and anterior part of intervening discs.
b) Middle column – posterior portion of the vertebral body posterior longitudinal ligament,posterior part of intervening disc.
c) Posterior column – spinal canal , transverse process, spinous process, lamina, pedicles, superior and inferior articular processes, Interspinous ligament.

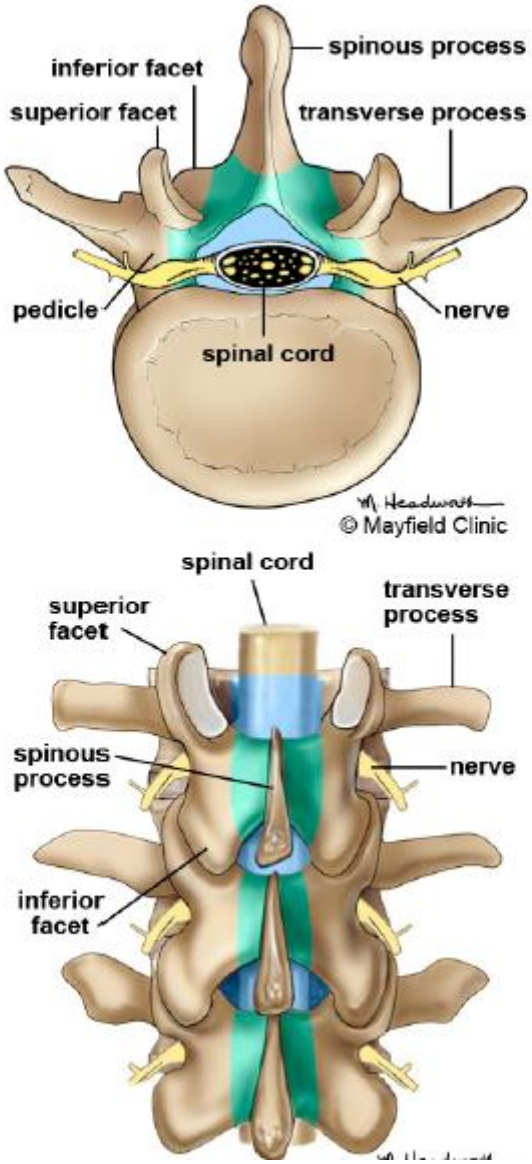


fig : 7

1. VERTEBRAL BODIES AND DISCS:

Lumbar spine have 5 vertebra with the intervening space filled by the intervertebral disc. The anterior and posterior longitudinal ligaments provides the additional stability to the spinal column. These will form the anterior and posterior columns of Denis. 80 % of the load will transmit through these columns in supine position.

Posterior elements:

Both lamina, pedicles, transverse process and the spinous process forms the posterior elements. Supraspinous , interspinous and intertransverse ligaments,facet capsules and ligamentum flavum interconnect the posterior elements .

3. LIGAMENTS OF THE SPINE

Ligaments are uniaxial structures and their efficacy in load carrying capacity is more when it acts along the direction of the fibres. The ligaments resist when they are subjected to tensile force.

Anterior longitudinal ligament:

It begin as the atlanto occipital membreane above the C2 level and continues as a broad band of tissue over the anterior vertebral body [3]. It is narrower at the thoracic region and broader at the cervical and lumbar region. It gets firmly attaches to the intervertebral disc and middle portion of the vertebra.

Posterior longitudinal ligament:

Posterior longitudinal ligament runs posteriorly along the vertebral bodies, gets firmly attaches to the intervertebral disc and upper and lower portions of the body leaving the middle portions where the venous plexus

is present. As it runs from cranial to caudal it becomes thinner. As it comes to the lumbar spine it becomes very thin not covering the dorsolateral surface of the disc. At the level of the disc some fibres of the ligament runs obliquely in a caudal direction towards the roots. In disc bulge cases these fibres get stretched and cause periosteal pain.

Ligamentum flavum:

The ligamentum flavum extends between two adjacent arches over the entire dorsal side of the spine.

In the lumbar vertebra the yellow ligament gets attached to the superior articular surface, as it gets expanded laterally it also gets attaches to the inferior articular surface.[3]

On flexion of the lumbar vertebra its length increases by 40%.

Supraspinatous ligament:

It connects the tips of the spinous processes along the whole length of the vertebral column. At the level of the C7 vertebra it becomes elastic called nuchal ligament.

Intertransverse ligament:

These are cord like structures extending in between the transverse process and they are connected to the muscles of the back.

Inter spinous ligaments: These extend from the root of the proximal spine to the apex of the distal spine. They are thick in the lumbar spine and thin in the dorsal spine.

Muscular attachments:

In lumbar spine the muscles gets originated from the capsule and the mammillary body unlike in cervico-thoracic region where there is no attachment with the capsule. Therefore, when the muscles contract it increases the intracapsular tension.

Facet joint:

The unique feature of the facet joint in lumbar vertebra is the sagittal orientation of the joint. The orientation allows for the flexion extension and the lateral bending of the spine. The facet joints prevent the axial rotation of the vertebra and the shear forces.

Intervertebral disc:

Intervertebral discs form 25% of the height of the vertebral column. [3] These discs not only form the structural components but also allows the mobility of the spine.

Disc consists of,

Nucleus pulposus

Annulus fibroses

Cartilage endplate.

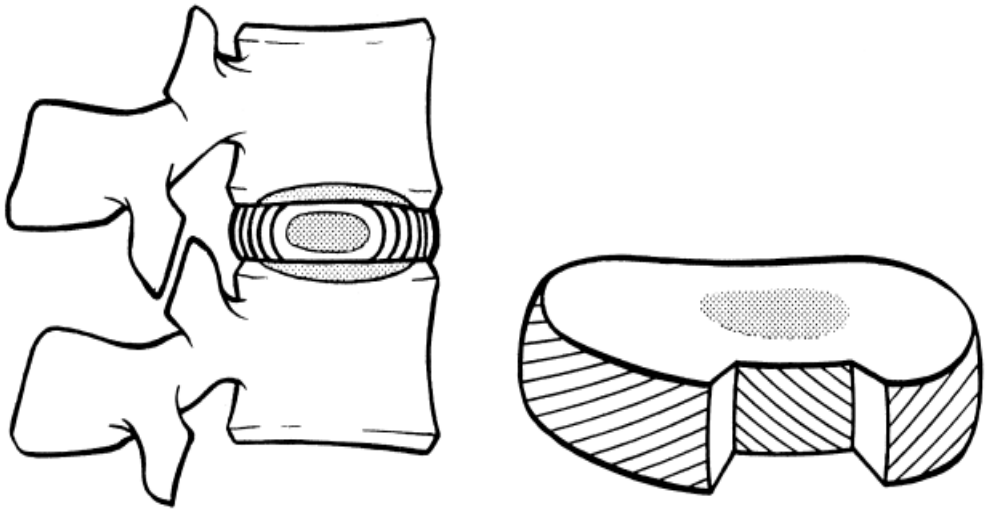


Fig : 8

Cartilage endplate:

It forms the upper and lower boundaries of the disc. It is made of hyaline cartilage attaches to the rim of vertebral body. At the attachment of the endplates there are sieve like lamina cribrosa through which metabolic activities like diffusion takes place.

Nucleus pulposus:

It is the remnant of the notochord [1]. It forms the central portion of the intervertebral disc. The tissue is made up of the bladder shape notochord cells and strands which together forms the chorda reticulum. It forms a mesh like structure by the connective tissue cells which is initially filled by the synovial like fluid and later by Gallert tissue[3]. As age increases the Gallert tissue becomes more brittle and loses its elasticity leading to degeneration. Injury to the disc may lead to

herniation of nucleus pulposus through the annulus causing nerve root compression.

Annulus fibrosus:

These are made up of dense inter woven collagen fibres which interconnects the vertebra. Sharpeys fibres forms the outermost boundary of the annulus which gets attached to the vertebral body. These are stronger ventrally and laterally than dorsally and dorsolaterally.

Functions:

Movement of the fluid inside the nucleus pulposus allows the vertebra to move front and back and it increases the flexibility . It acts as the shock absorber and it allows the flexion and extension of the spine

Pedicles:

A thorough knowledge about the pedicle anatomy is necessary for using pedicles as the screw purchase site. Pedicle dimensions vary progressively from the upper thoracic vertebra to the lumbar spine [4]. Data obtained by Zindrick et al by studying 2905 pedicles concluded the morphological characteristics and the depth of screws inserted safely

L5 Pedicle is the widest and T5 pedicle is narrowest in the horizontal plane [4]. And also T11 pedicle is widest and T1 pedicle is the narrowest in

the sagittal plane [4]. As the pedicles are oval shaped they are wider along the sagittal dimension.

The L5 pedicle is directed Caudal in sagittal orientation and the pedicles are cephalad in L3-T1 .The depth of the anterior cortex is longer along the axis of pedicle than the midline axis of the vertebra. (fig : 9)

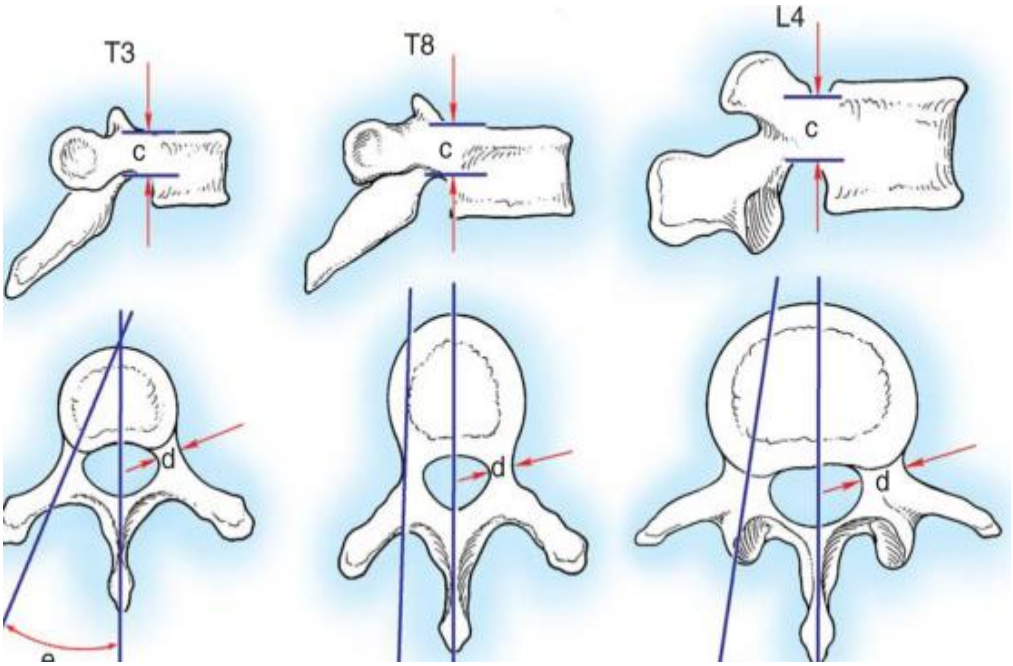


Fig:9

Arterial circulation:

Branches from the posterior intercostal vessels and the lumbar arteries forms the main blood supply to the dorso-lumbar region. A branch from the ilio-lumbar artery forms the main blood supply to the lumbosacral region.

All these arteries will give rise to a dorsal ramus at the level of intervertebral foramen. This is further divided in to spinal branch, medial and lateral cutaneous ramus[3].

The caudal and the lateral part of the capsule is supplied by the medial ramus and the cranial part is supplied by the direct branch from the dorsal ramus. These branches run around the base of the spinous process forming the intersegmental anastomoses (Fig : 10)

Clemens described in1961 that the vertebra derives its blood supply from the periosteum by Volkmann"s canal.

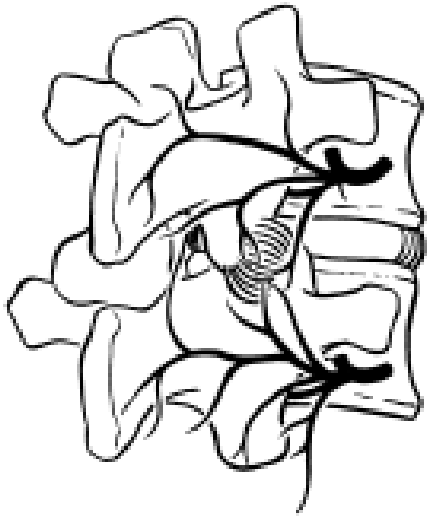


Fig : 10 Arterial supply of lumbar spine.

Venous circulation:

Divided into external and internal venous plexus. The external plexus lies between the base of the spinous process and the transverse process against the posterior arch and the joints. The internal vertebral plexus courses longitudinally within the spinal column[3].

These veins are interconnected by transverse anastomoses. These veins do not have the valves therefore the direction of flow can be altered according to the local pressure ratio. From base of the skull to sacrum the vertebral venous system forms a chain of anastomoses. Ghazwinian and Kramer in1974 described that filling of these veins is based on the central venous pressure.

Innervation :

The intervertebral joints are innervated by the spinal nerves coursing through the respective intervertebral foramina. Before leaving the Intervertebral foramen spinal nerves give rise to a dorsal ramus and the meningeal branch.(fig 11)

Joint capsule, musculature and the skin are innervated by the dorsal ramus and its branches (Emminger 1954).

The Meningeal branch forms the neural plexus. It originates distally in the spinal ganglion and absorbs many fibres from the sympathetic trunk (Luschka).

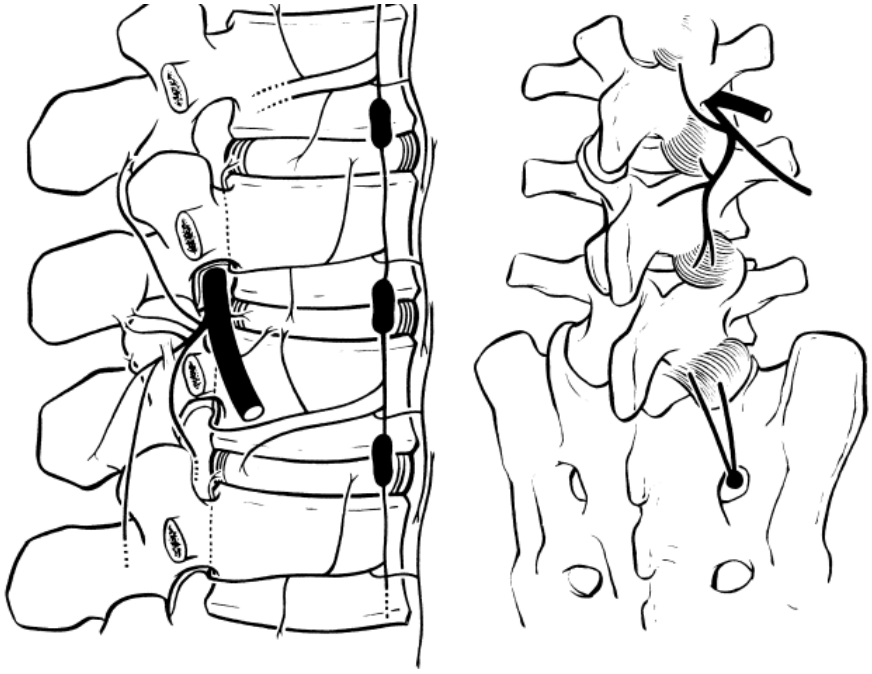


Fig. 11 Multisegmental innervation.

Pars interarticularis:

The intervening part of the lamina between the superior and inferior articulating facet is called as pars interarticularis.

Spinal cord:

The spinal cord ends at the level of L1 L2 intervertebral space in adults and at L3 in the neonates. It is covered by the meninges .The lesion at the level of L1 either cord lesion or the root lesion or the combined injury. Injury below L1 produces only the root lesion. Half of the spinal canal is filled by the cord and the remaining by the epidural fat, CSF, and the meninges.

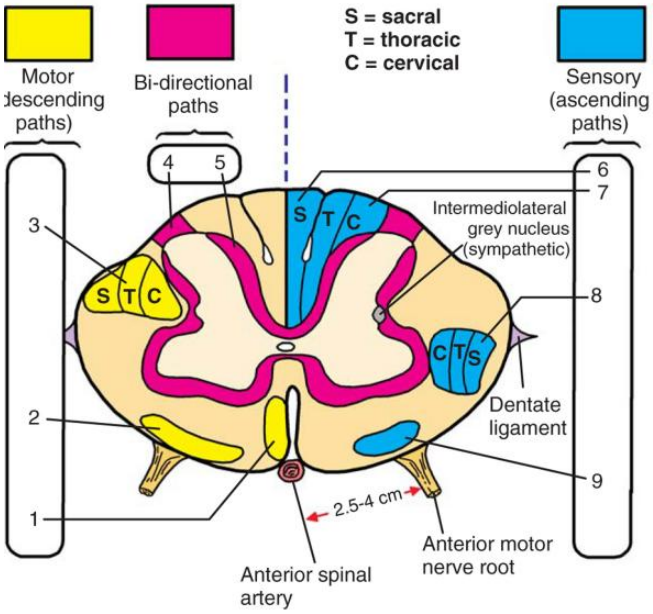
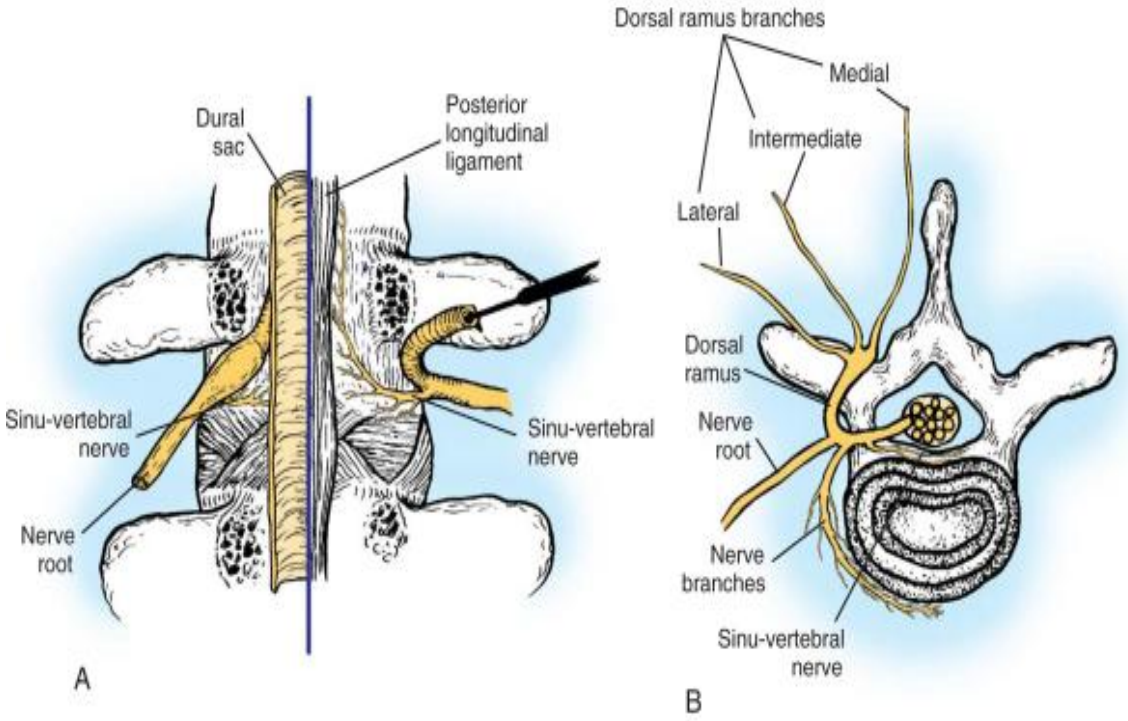
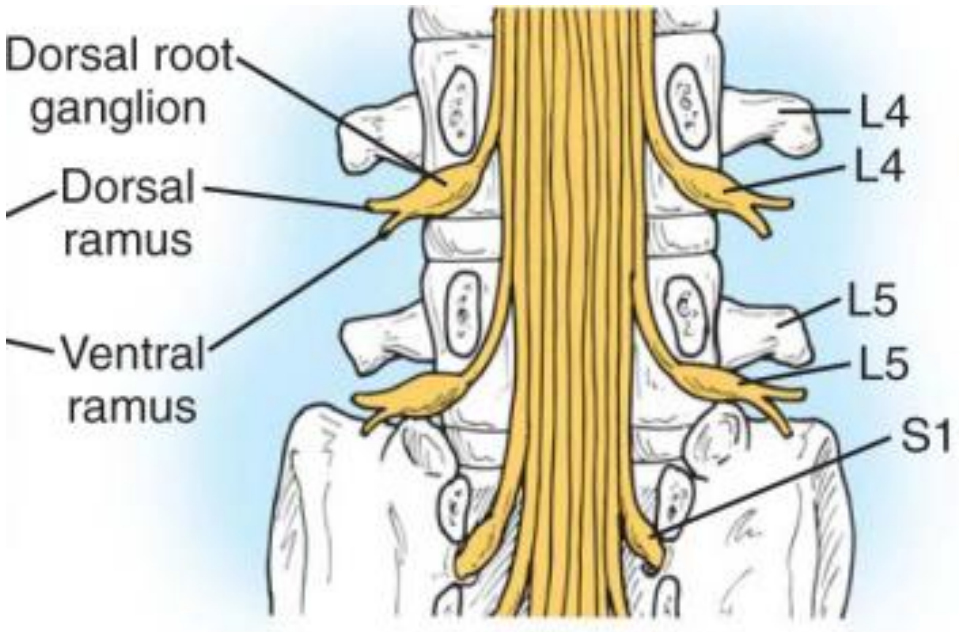


Fig : 12

Spinal nerves:

The lumbar spinal nerves exits through the intervertebral foramina. Dorsal root ganglion lies at the intervertebral foramen (Fig:13). From the dorsal root ganglia three branches arise , ventral branch is very important and most predominant second branch is the sinu vertebral branch and supplies the posterior longitudinal ligament and the posterior aspect of the vertebral body. The third branch is the dorsal ramus. In lumbar disc pathology the distal nerve gets affected commonly [4].


Dural sac
Posterior longitudinal ligament
Sinu-vertebral nerve
Sinu-vertebral nerve
Nerve root
A
Dorsal ramus branches
Medial
Intermediate
Lateral
Dorsal ramus
Nerve root
Nerve branches
Sinu-vertebral nerve
B


Dorsal root ganglion
Dorsal ramus
Ventral ramus
L4
L4
L5
L5
S1

.

Fig : 13

BIOMECHANICS

Lumbar spine is frequently activated in the body which leads to disc problems , sciatica and back pain. These results from improper positioning, lifting heavy objects and improper positioning for a long time.

In human spine the morphology of each vertebrae , height of the disc space, orientation of the facet joint differs. These differing posterior morphology affects the biomechanical behaviour of the lumbar spine.

Kuo et al in 2010 concluded that Von mises stress and strain is more in lower lumbar spine. The intra discal pressure increases with pre load that too in flexion than extension and axial rotation. In extension the pressure is decreased in L2/L3,L3/L4,L4/L5 levels.

Stress: Stress is defined as the force required to elongate a fibre, which is measured in Newton[58].

Strain:

Strain is defined as the extent to which the fibre is elongated corresponding to the applied stress. Strain is measured as the percentage increase in length[58]. (fig : 14)

Crimp:

The collagen fibres assumes a wavy shape called the crimp. It forms the toe phase in the stress- strain curve pattern.

Stiffness :

It is the resistance of a given structure to deformation.

Hysteresis:

It is a behaviour of the stressed ligament when the force is removed. The restoration of the initial length takes longer time and also initial length could not be obtained completely. This shows the amount loss of energy when the structure is stressed. This difference in behaviour is called the Hysteresis.

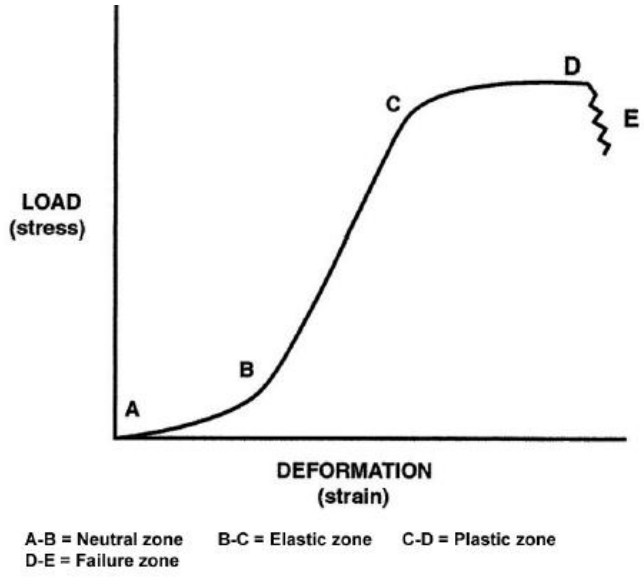


fig : 14

The main movements of lumbar spine are, flexion,extension, compression,distraction and translation (fig : 15)

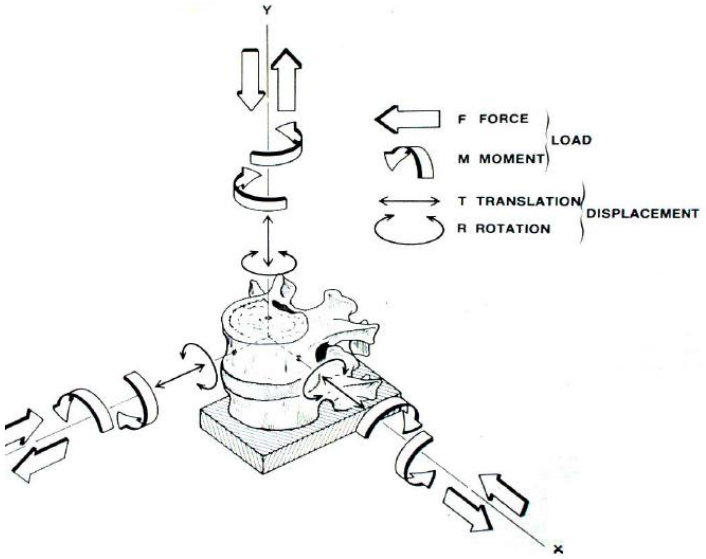


fig : 15

The intervertebral disc and the ligamentous complex are the main constraints of rotation of the lumbar spine. The interaction between spinal column are necessary for normal physiological function, load transmission, and kinematics.

Range of movements varies between vertebra. The anterior part of the annulus fibrosus is compressed while the vertebra is compressed anteriorly. As 80 % of the body weight gets transmitted through the anterior column, during rotation, the weight of the body produces a shear stress leading to the translation of the disc

(fig : 16)

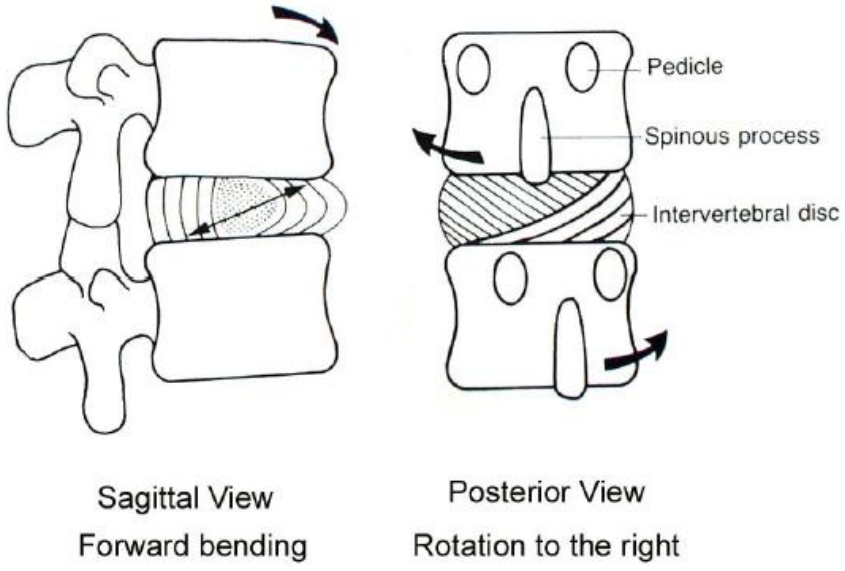


fig : 16

Instantaneous axis of sagittal rotation (fig :17) is located in the posterior 1/3 of the disc. The superior and inferior facet along with the disc forms the major constraint.

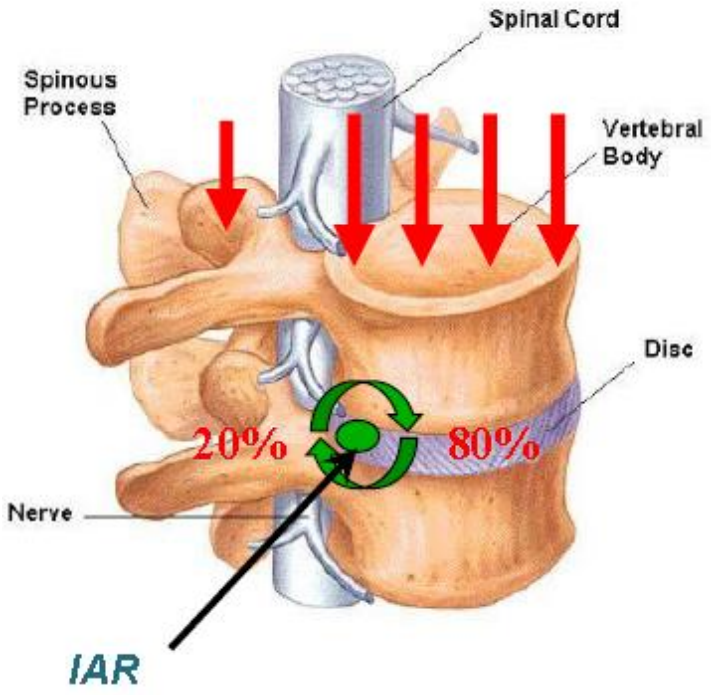


fig : 17

The intervertebral disc and the annulus gives nearly 50% stability. Various mechanism of neutralising the instantaneous axis of rotation are, (fig: 18)

Axial interbody fusion

Trans facetal fusion

Anterior plate fixation

Pedicle screw fixation.

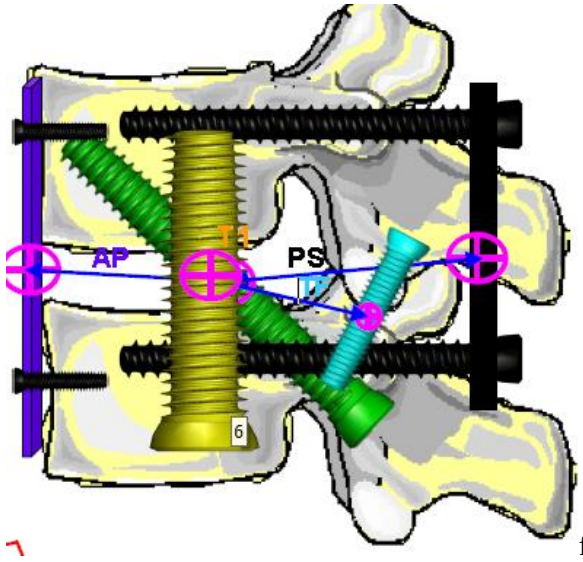


fig : 18

Among these constructs interbody is the best as it is very much near to the Instantaneous Axis of Rotation minimising the shear forces.

L5 / S1 disc space.

The disc between L5/S1 has the potential to incur the greatest moment and is one of the most vulnerable tissues to force-induced injuries.Between 85-95% of all disc herniations occur

relatively equally at the L4/L5 & L5/S1 levels.

Spine usually does not fail in pure shear force. Also in normal physiological activities pure tensile loading does not occurs,but undergo tensile loading under bending axial rotation and in extension.

Pedicle screw insertion techniques:

The pedicles of the thoraco -lumbar spines are tubular structures connecting the posterior elements to the anterior body. Medial to the pedicles lies the dural sac and inferior to the pedicle lies the nerve roots. The medial cortex of the pedicles are stronger than the lateral cortex, hence the pedicle breach commonly occurs at the lateral cortex than the medial cortex.

Boucher [59] in 1950 introduced the pedicle screw instrumentation and then was used by Roy –Camille et al[60]. Pedicle screws are biomechanically superior than the hook system and rod system and they

are safe compared to the sublaminar wires which may cause neurological deficit.

As the pedicles in the lumbar spine are larger the margin of error are higher compared to the smaller pedicle thoracic vertebra leading to neurological damage, pleural injury, major vessel injuries, thoracic duct injuries.

The facet joints, transverse process and the mammillary process forms the main landmarks for the pedicle screw insertion. The basic three techniques of pedicle screw insertions are intersection technique, the pars interarticularis technique, the mammillary process technique[4]. Other techniques are Free hand technique, Image guided or stereotactic pedicle screw placement, and fluoroscopic guided technique.

1. Intersection technique:

This is the most common technique to localise the pedicle. The land mark is to draw a line from the lateral aspect of facet joint which intersects a line that bisects the transverse process. (Fig :`19)

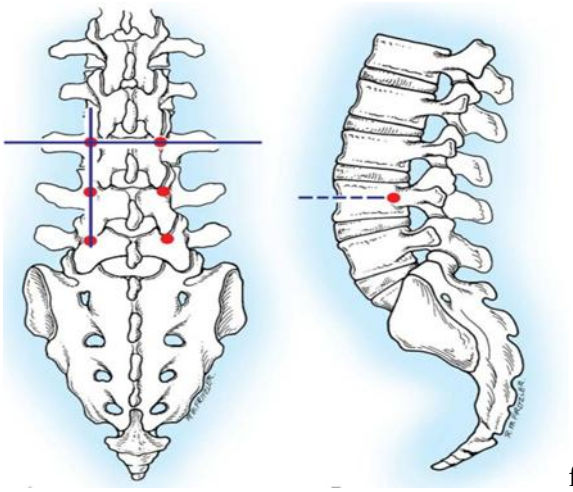


fig : 19

2. Pars interarticularis technique:

This is the area where the pedicle connects the lamina4.

The mammillary process entry point is more lateral than the intersection point entry point which in comparision is more lateral than the pars interarticularis technique.

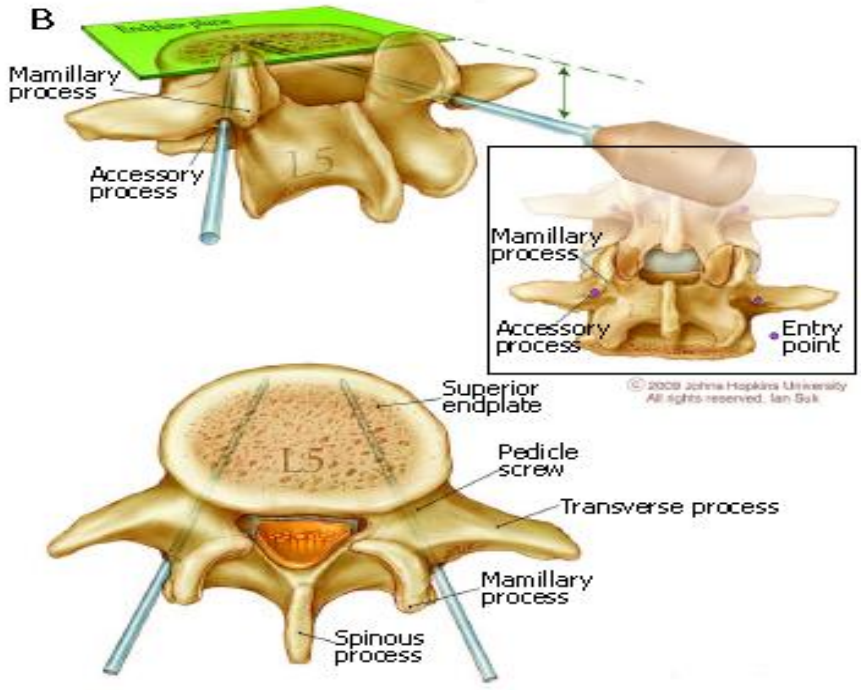
3. Mammillary process technique:

Based on the prominence at the base of the transverse process. This is used as the starting point for drilling the pedicle.

4. Free hand technique of pedicle screw application.:

In lumbar spine the point of entry is the junction of transverse process,pars interarticularis and the mammillary process[61]. After making the entry, a trajectory that is parallel to the superior end plate is used due to the

better biomechanical stability (fig 20). The gear shaft pedicle probe is used to probe the lateral cortex first up to 15-20mm then directed medially as the risk of medial breach is much reduced at this point. The accuracy rate ranged from 71.9% to 98.3%[62-64]. The accuracy rate gets decreased at the mid thoracic level. The main advantage of free hand technique is decreased radiation exposure and decreased procedure time.



Pedide entry points for L5 vertebrae

fig : 20

5. <u>The canoe technique to insert lumbar pedicle screw:</u>

The spinous process, lamina, facet joint,and the transverse process are exposed. The typical lumbar transverse process is flat and there is a central ridge which is continuous with the mammillary process of the

superior facet. Using a curette a unicortical breach or canoe is made along the long axis of the transverse process towards medially. At this point the pedicle will be exposed. (fig: 21)

But the disadvantage is that it requires a wider exposure laterally leading to more blood loss[65].

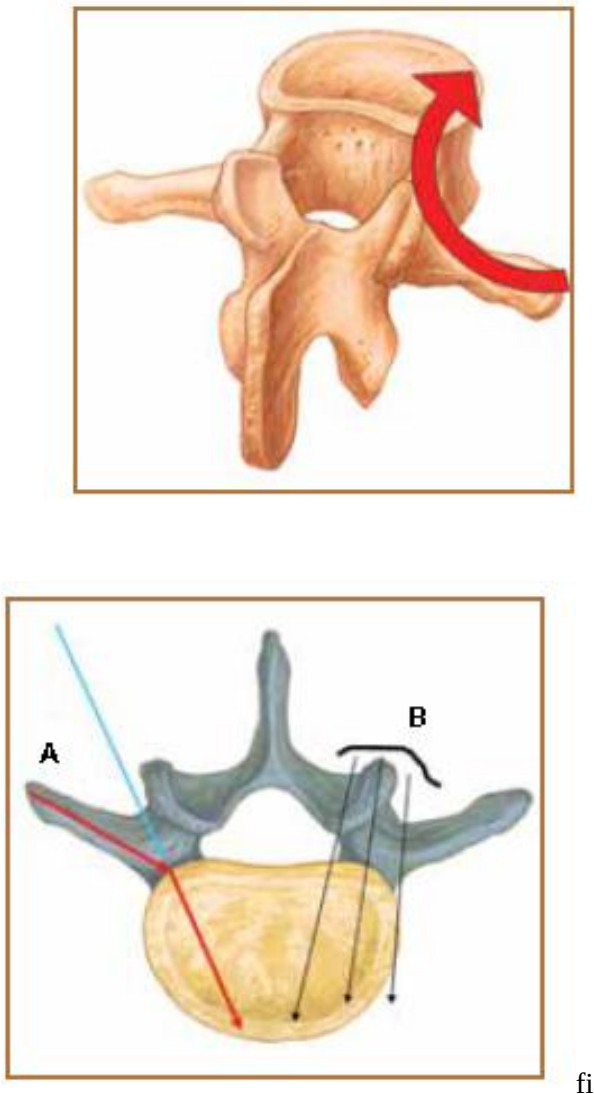


fig : 21

6. In - Out Technique:

This techinique is used in thoracic spine, in which the pedicle screws are intentionally placed laterally to decrease the risk of canal breach.

Breach classification:

The incorrect placement of pedicle screws is a potential source of great patient morbidity. The postoperative CT scan is the most useful modality for diagnosing the malposition of the pedicle screws.

There are various scales for the cortex violations of which Gertzbein scale is routinely used.

Gertzbein classification[62]:

Grade	Breach distance (Distance measured from the medial border of the pedicle)
0	0mm(no breach)
1	<2mm
2	2-4mm
3	>4mm

The Gertzbein classification was intended to only asses the degree of spinal canal encroachment,as lateral screws were excluded from the graded classification.

Youkilis et al[66] classified in to three grades .

1. Grade 1- No pedicle breach
2. Grade 2- <2mm
3. Grade 3- >2mm

Recent studies have expanded on the original Gertzbein scale by applying it in every direction of possible cortical breach.

Another study insisted to use the graded classification in each of six possible directions of cortical breach.Anterior, lateral, medial, inferomedial, inferolateral, superior. Each screw was given six different grades ranging from 0-3.

Gertzbein and Robbins noted that the cortical breaches of more than 4mm were associated with neurological deficit and also they conclude the this 4mm range may constitute the safer zone for pedicle screw placement at T10 toL4.

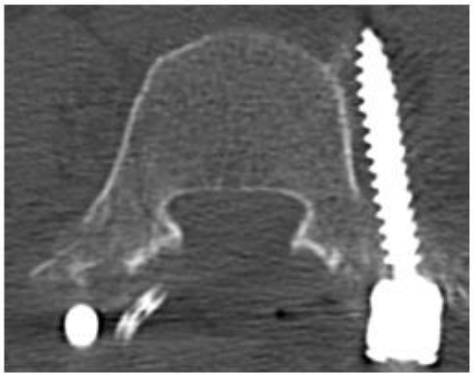


Figure 1 Axial computed tomography image depicting lateral breach of a pedicle screw intended for the L4 vertebrae.

fig: 22

Heary classification:

The Heary classification takes into consideration the cortical repercussions of cortical breaches. According to them in the thoracic spine the laterally penetrating pedicle screws are often contained within the posterior rib. This additional form of rib purchase could theoretically increase pullout strength.

This was the first classification which used that graded the anterior breaches i.e.those through the vertebral body (Grade 3). However this classification doesnot consider the metric extent of breach in any direction. The Heary classification was novel in that it was the first classification which was more relevant clinically.

Heary classification:

Grade	Breach
1	None
2	Lateral , but screw tip is within Vertebral body
3	Anterior or lateral breach of screw tip
4	Medial or inferior breach
5	Breach that requires immediate revision

Biomechanics of pedicle screw instrumentation failure:

Posterior instrumentation failure:

Instrumentation failure results when the pedicle screws are placed in a position where the bending loads produced by forces that acting eccentrically to implant's central axis exceed the load bearing capabilities of the implant

Causes:

1.Pseudo arthrosis develops leading to continuing bending motion until fatigue failure occurs.

2. Anterior column deficiencies which may be due to the vertebral body tumor or unstable vertebral fractures.

3. Spondylolisthesis

4. When the hold of the screw to vertebra is less as in osteopenia will lead to pull out of the screw[68].

Pseudoarthrosis:

Pseudoarthrosis often predisposes to the implant failure. If pseudoarthrosis develops following the posterolateral bone grafting, the success of repeat posterolateral bone grafting is compromised because of the devascularised fusion bed which necessitates the interbody fusion.

Anterior column deficiencies:

80% of the load gets transmitted through the vertebral body. Therefore a deficient anterior column may produce a big bending stress to the posterior instrumentation. Mclain et al reported about 60% failure in comminuted thoracolumbar vertebral fractures if the posterior construct alone is made[69].

Osteporosis:

The Posterior instrumentation failure may correlate with the Bone mineral density.The insertion torque has been correlated with the Bone

mineral density and the screw pullout. To increase the screw pull out strength, surgeon should choose a long screw or larger diameter screw.

The anterior instrumentation failure occurs commonly due the implant failure or subsidence of the cage. This causes the failure of fusion and the recurrence of the deformity. When there is loosening of screws and osteoporosis, it can be prevented by the bicortical purchase and using wider diameter scew[70].

If a smaller size strut or a cage is used it may get pistoned into the adjacent vertebra leading to the collapse and recurrence of deformity . The anterior construct failure can be prevented if the integrity of the vertebral endplate is maintained. If there is doubt about the anterior construct, always add a posterior support.

MATERIALS AND METHODS

Aim of this study is to analyse the functional outcome of revision lumbar surgery for failed back surgery syndrome.

This is a retrospective and prospective study conducted at the Institute of Orthopaedics and Traumatology, Rajiv Gandhi Govt.General hospital, Chennai from September 2012 to September 2014.

The patients were included in the study based on the following inclusion criteria after getting consent from the patient.

Inclusion criteria:

1. Recurrent disc herniation
2. Spinal stenosis
3. Post – laminectomy Instability
4. Adjacent instability
5. Pseudoarthrosis
6. Flat back syndrome

Exclusion criteria:

1.Post op Discitis.

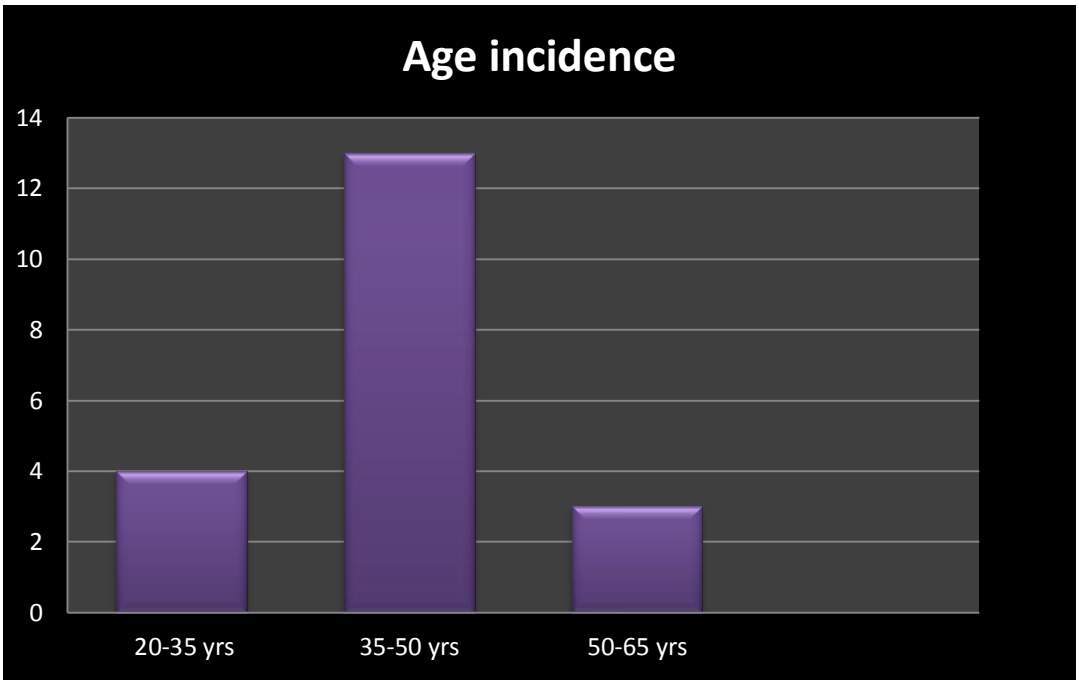
2.Primary disc prolapse

3.Primary Spondylolisthesis

4.Primary Canal Stenosis.

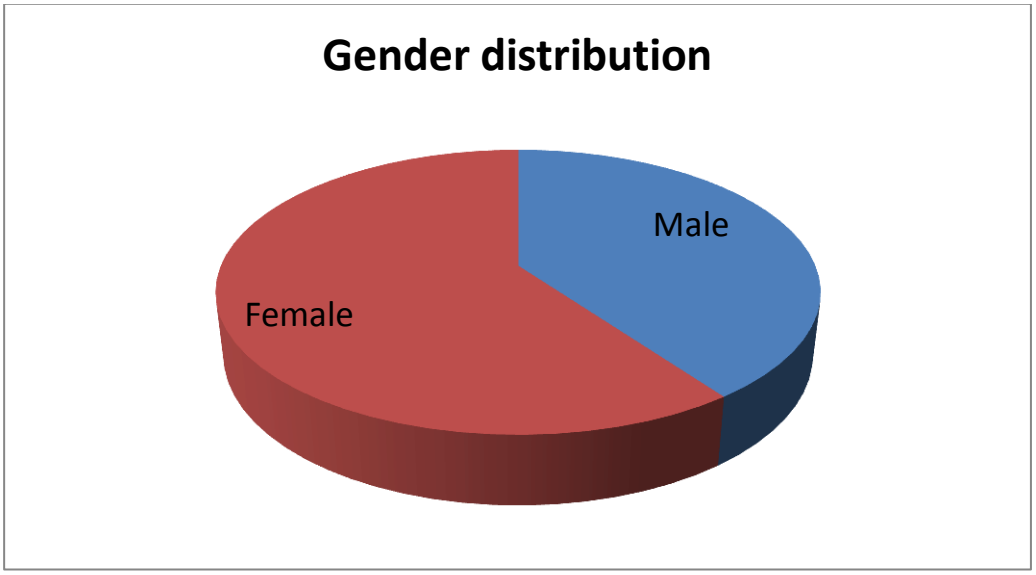
Age Incidence:

Patients age ranged from 23-60 yrs. Mean age- 41.15yrs.



Sex distribution:

Male: Female – 8:12



Patient evaluation:

Patients with chronic persistent or recurrent or worsened pain following a spinal surgery were evaluated clinically, and radiographically and the reasons for recurrent pain are narrowed down .

The pain may be a low back pain or radiating pain or the combination of both. Persistent motor weakness and sensory deficit are not elements of failed back syndrome. Therefore correlating the physical symptoms with the radiological findings of CT myelogram , MRI and Xray is mandatory.

Pain Free interval:

The duration of pain free interval is very important in the evaluation of the reason for recurrent pain.

1.If the patient awakes with the similar complaints immediately after the surgery, it may indicate wrong level decompression, or inadequate decompression.

2. If the pain recurs after 6 months it indicates recurrent disc at the same level or adjacent level degeneration.

3. Pain recurring in 1-6 months indicates scar tissue.

Pattern of pain:

1. Patients having predominantly leg pain may have spinal stenosis or recurrent disc prolapse. Scar tissue also predominantly produces leg pain.
2. Back pain suggests instability, or possibly scar.

Number of previous surgeries:

The number of previous surgeries will have an impact on the outcome of revision surgery. According to the literature the outcome reduces to 50% for the second surgery.

Objective evaluation:

1. Tension Sign.
2. Neurological examination.

Tension sign:

Pain elicited while doing straight leg raising in the sitting posture.

If there is no change in the neurological findings and a normal tension sign, the probability of mechanical reason for the pain is unlikely.

If there is postoperative neurological deficit and tension sign there may be a possibility of mechanical compression of the cord.

Neurological Examination:

Lumbar Nerve roots	Functions
L1,L2	Hip Adductors
L3L4	Knee flexion
L5 ,S1	Knee flexion
L5	Great toe extension
S1	Great toe flexion

Neurological evaluation is by the ASIA impairement scale: (fig : 23)

Grade A: Absent motor(grade 0/5) and sensory function below the injury level.

Grade B: Sensation present, motor function absent

Grade C: Sensation present but poor motor function (grade 1/5- 2/5)

Grade D: Sensation present , motor function active and useful.

Grade E: Normal motor (grade 5/5) and sensation function.

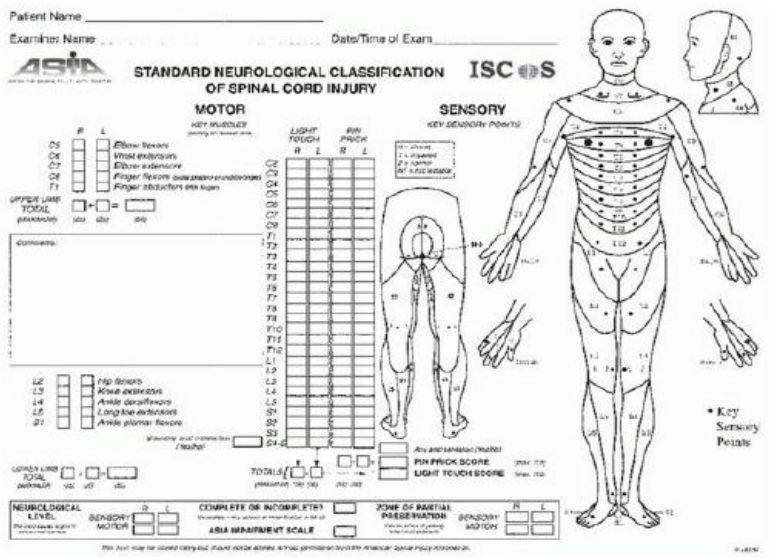


fig : 23

Pre operative Pain evaluation by Visual analogue score (fig: 24)

fig :24

Disability is assessed by the Oswestry disability index:

It is a 10 section questionnaire each section is scored from 0-5 according to the disability.

The score is calculated by the following formula

Total scored/total possible score ×100

Interpretation of scores:

0% to 20%- Minimal disability

21% to40%- Moderate disability

41%-60%- severe Disability

61%-80%- Crippled

81%-100%- Bed bound

Objective evaluation also includes to rule out non orthopaedic causes of pain like, pancreatitis, diabetes and abdominal aneurysm.

Radiological evaluation:

Xray:

Plain x rays antero posterior , lateral and weight bearing flexion extension views are the key to diagnose the abnormal translation of the vertebra which indicates instability.

An angulation of 11° and the sagittal translation of 12% are considered as positive for instability . In the L5 S1 region a 25% translation or a19° angulation are considered as instability[73].X-ray lumbosacral spine oblique views are taken to detect the parsinterarticularis defect or lysis. Bilateral lysis will produce

anterior displacement of the vertebral body from the posterior elements. It is seen as the broken neck of Scottie dog in an oblique film. (fig: 25)

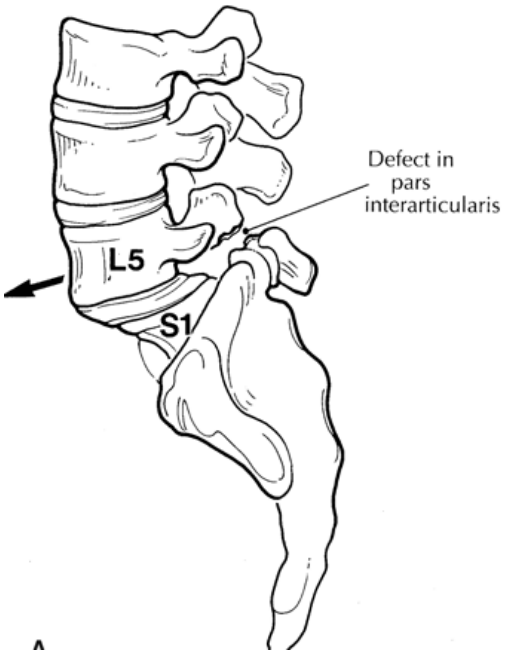


fig :25

Computed Tomography: The X-ray plain films cannot delineate soft tissues but CT by using its resolution can differentiate soft tissues also to some extend.

Ligamentum flavum, CSF,nerve roots,epidural fat ,can all be delineated by the CT.

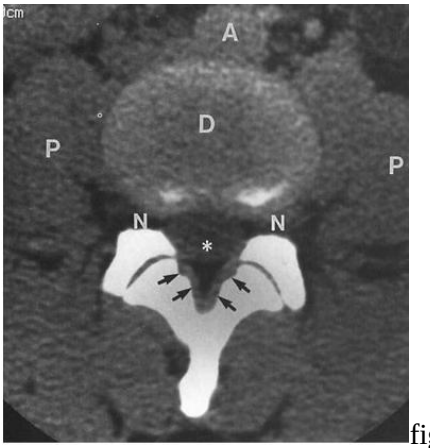


fig : 26

The bony defects as in case of lysis of the pars interarticularis can be identified in the axial section of CT.

fig : 27

The CT scans are also used to judge the accuracy of screw placement postoperatively. Based on the amount of canal breach Gertzbien classified the medial canal breach into four grades.

CT myelogram:

It is very sensitive in diagnosing the lesions of the spinal canal like disc herniations and tumor. The presence of subarachanoid contrast will detect the lesions around the cauda equina.

MR imaging:

MR imaging are very sensitive in diagnosing the changes in the bone marrow of vertebral bodies. The commonly used sequence for MR imaging is

the SPIN-ECHO which can be weighted for either T1 or T2. In a normal human in T1 image the vertebral body will be hyperintense and the CSF have low signal . The neural elements will be in neutral intensity.

In T2 image the bone marrow will be hypointense and the CSF will be hyperintense. The discs will have an intermediate signal in T1 image and in T2 image it appears hyperintense. The dehydrated disc will be hypointense.

MRI is also useful in detecting the scar tissue (fig : 28) which appears as a soft tissue signal and which can be further enhanced by the contrast showing well perfused scar. MRI are also useful in diagnosing recurrent disc herniations.

fig :28

MR contrast imaging showing the highly vascular scar tissue

MR imaging showing recurrent disc.

Non – Operative management:

Nociceptive pain unresponsive to oral anti-inflammatory drugs caused by the disc herniations and stenosis are often treated by steroid and anesthetic injections. The use of epidural steroid for the pain relief in case of nerve root irritation is very effective and safe when proper patient selection and technique is used.. Lutze et al. compared the transforaminal steroid injection versus trigger point injection showing 84% success rate among the steroid injections compared to 48% among the trigger point injection patients.

Although epidural steroid may be effective in the unoperated spine,the results for treating the recurrent disc and stenosis are unpredictable. The nerve roots obtain its nutrition from the cerebrospinal fluid. Because of the epidural fibrosis and the fibrosis around the nerve roots , nerve root ischaemia results. Epidural steroids are given not more than four doses.

There are a number of conservative modalities to treat the back pain and leg pain , ranging from bed rest to expensive traction apparatus. The most simplest form of treatment is rest. Strict bed rest for 2 days is enough for better recovery than rest for longer period. Semi-Flower position[11] i.e., lying in a semi-lateral position with hip and knee flexed with a pillow in between relieves most of the tension at the disc and nerve root. Muscle spasm is relieved by massaging and ice packs. NSAIDS gives pain relief and anti- inflammatory effect. As the pain gets relieved the patient should be asked to start isometric lower limb exercises and abdominal exercises. Then the patients are advised to

start walking and encouraged to do daily routine activities as pain permits which is better than strict bed rest.

Back school[14], educates for the complete recovery of the patients with back pain. Bergquist- Ullman concluded in their study that combination of back strengthening exercises and education aids in good outcome than the placebo. Because of the drug habituation, the trend of using narcotics is moving away.

Strong anti-inflammatory drugs like steroids can also be used in acute cases. Mood elevators like amitriptyline can also be used. The use of physical therapy should be targeting the cause and should be used judisiously. Acute pain is treated by the extension exercises not by the flexion exercises . The improvement in extension exercises indicates a good outcome in the conservative modality. Any exercise which increases the pain should be withheld. Lower limb exercises may improve the power of the lower limb muscles and take away the stress of the back muscles.

Transcutaneous electrical nerve stimulation, ultrasound therapy, traction which may range from skin traction to the intermittent pelvic traction may be helpful.

Operative technique:

After assessing the patients for surgery ,they are posted for surgery after a clean surgical preparation of the local parts and preparing the bowel.Written and informed valuable consents were obtained from all patients.

The preoperative planning was done for each case whether to stabilise the spine , or to do decompression or to fuse the spine based on the pre op evaluation.

Surgical Implants: (fig : 29)

Pedicle screws 5.5 mm or 6.5mm based on the pedicle size

Rods

Trans-foraminal lumbar inter body cages

Interbody mesh cage

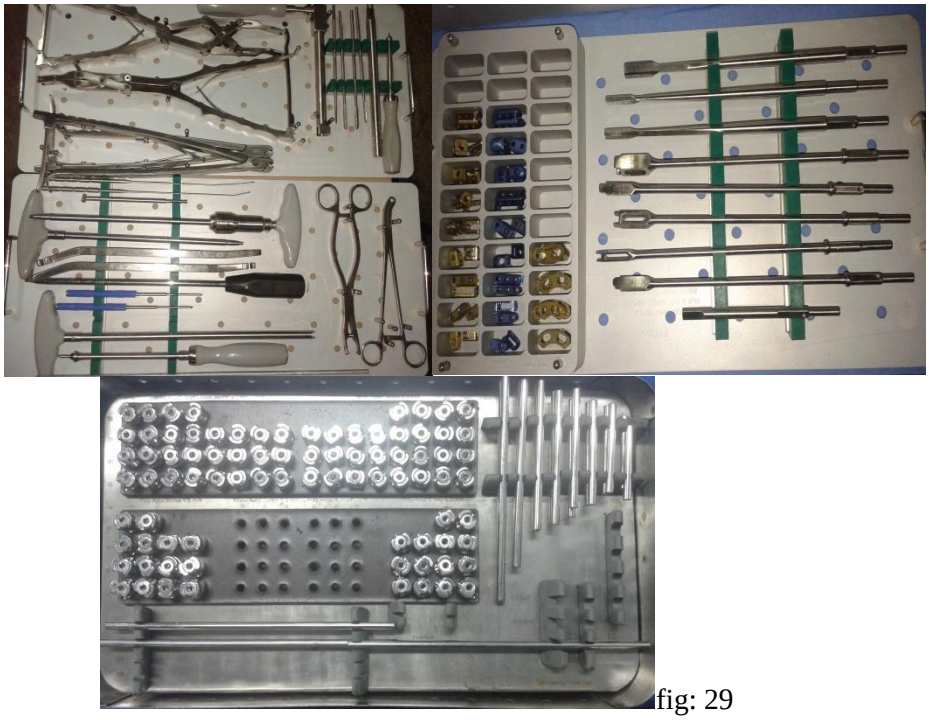


fig: 29

19 of our patients are operated from the posterior aspect and 1 from the anterior approach. A single dose of III generation cephalosporin was given intravenously half an hour before the surgery after test dose.

Posterior approach:

Under General anesthesia patient was put on prone position on a well padded spinal Halls frame.Prone position decreases the venous pressure thereby reducing the bleeding. Screws were insertion under C-Arm guidance.

Surgical steps[74,75]:

1 :50000 epinephrine solution is used to infiltrate the skin, subcutaneous tissue and the para spinal muscles. Care should be taken not to injure the nerve fibres as there is no lamina and ligamentum flavum in case of previous laminectomy. The skin incision is made through the previous scar.The dissection was carried from the normal tissue laterally to find out the depth of the spinal canal.The dissection was done meticulously as there was dense scar tissue in the epidural space.The scar tissue surrounding the pathological surface alone are removed and rest of the scar were left untouched. In some cases the scar was elevated away from the bone at lateral margin of the old laminectomy. The nerve roots are visualised at the lateral gutter and the foramen were enlarged to free the nerve roots and then the discectomy was proceeded.In case of instability transforaminal lumbar interbody fusion was done in five cases and posterolateral fusion in one case. In cases of implant failure implant exit was done first and then redo stabilisation was done. In one case the shaft of the broken screw in the vertebral body was left unremoved.

The pedicle entry points were identified after dissecting the soft tissues at the junction of inferolateral part of the facet and the mid point of the transverse process.Entry point was made with an awl pedicle probed under the C-arm guidance and four walls checked with a ball tipped probe. Tapping was done up to the pedicle. Appropriate screw length and size (5.5mmor6.5mm based on the pedicle size) was inserted. Appropriate rod size was measured and contoured if necessary and inserted in-to the screws heads and then nuts were applied.Through the foramen the disc space was reached, the disc material was removed with the help of a disc punch and the endplates were curetted out . The TLIF cage filled with the bone graft was inserted in- to the disc space.

In case of posterolateral grafting the transverse processes of the adjacent vertebra are decorticated and the graft material was placed on the intertransverse membrane.Thorough wound wash was given with normal saline and wound closed in layers with a suction drain in situ.

Anterior approach[75]:

The anterior exposure is done with the assistance of a general surgeon. Under General anesthesia,patient is positioned in a semilateral position 45° to 90° angulated from the horizontal. The 12th rib of the affected flank and the

pubic symphysis are palpated The lateral border of the rectus abdominis is palpated 5cm lateral to the midline.

Skin incision is made from the posterior aspect of the rib upto the lateral aspect of the rectus in the midway between umbilicus and pubic symphysis. External oblique, internal oblique and the transverse abdominis are cut in line with the skin incision. With the finger dissection the retroperitoneal fat along with the contents are pushed anteriorly and medially. Along the psoas muscle the lateral surface of the vertebral body is reached , the fractured vertebra are nibbled out and the end plates of the adjacent vertebra are curetted out . Bone graft harvested from the iliac crest is prepared and packed into the appropriate size mesh cage and placed in between the two bodies. Anterior stabilisation was done with two appropriate screws with bicortical purchase. Thorough wound wash was given and wound closed in layers with a suction drain.

Post operative protocol:

Post operatively patients were treated with a III generation cephalosporins and an aminoglycosides as intravenous antibiotics for 5 days , and oral antibiotic till suture removal.

Log rolling was done every 2 hrs. Bladder and the bowel are taken care .

Drain removal was done on the fourth postoperative day. Patients were allowed to sit from the second postoperative day with a brace and patients without neurological deficit are mobilised from the third postoperative day with a brace. Suture removal was done on the 12^{th} postoperative day.

Postoperative X-rays are taken routinely before discharge. Neurological evalution was done post operatively and graded according to the ASIA score.

In this study we had one case of epidural tear and two cases of infection as complications.

Dural Tear: One patient had dural tear while operating for the cage failure.Once the dura was torn the wound will get filled up with the CSF. The filled fluid should not be aspirated with the suction tip because it may inadvertently injure the nerve fibres causing neurological deficit. It should be aspirated with the help of a gauze pad. Once it gets aspirated the tear is packed with a gel foam, the head end should be lowered down and the tear is repaired with a 4-0 silk. If the defect is large a graft is prepared from the thoraco lumbar fascia and sutured to the dura. The idea is to suture the defect in a water tight seal. If the tear is at an inaccessible site a muscle or fat plug is used . After the closure is done,the leak is tested with Valsalva manneoure. Drain should not be kept. Post operatively patient should lie in a flatbed for three days.

Infection:

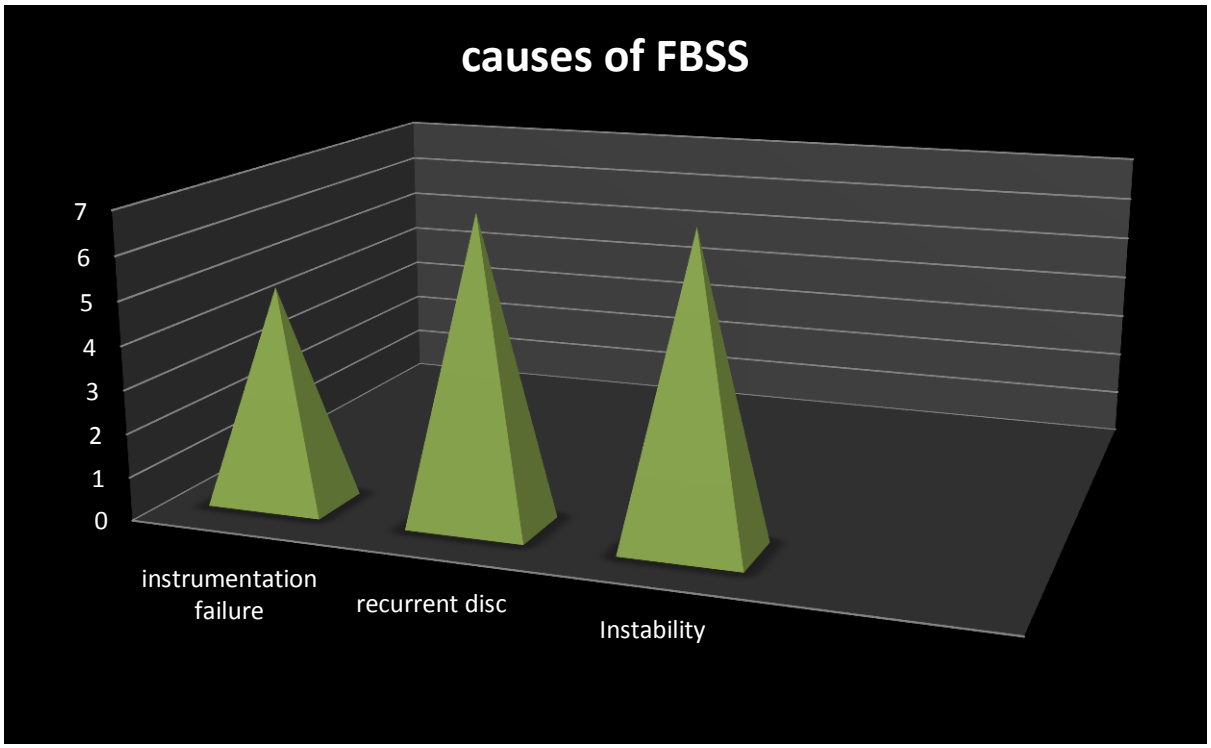
In this study we had three cases of infection, for which wound wash was given in two cases and implant exit was done in one case.

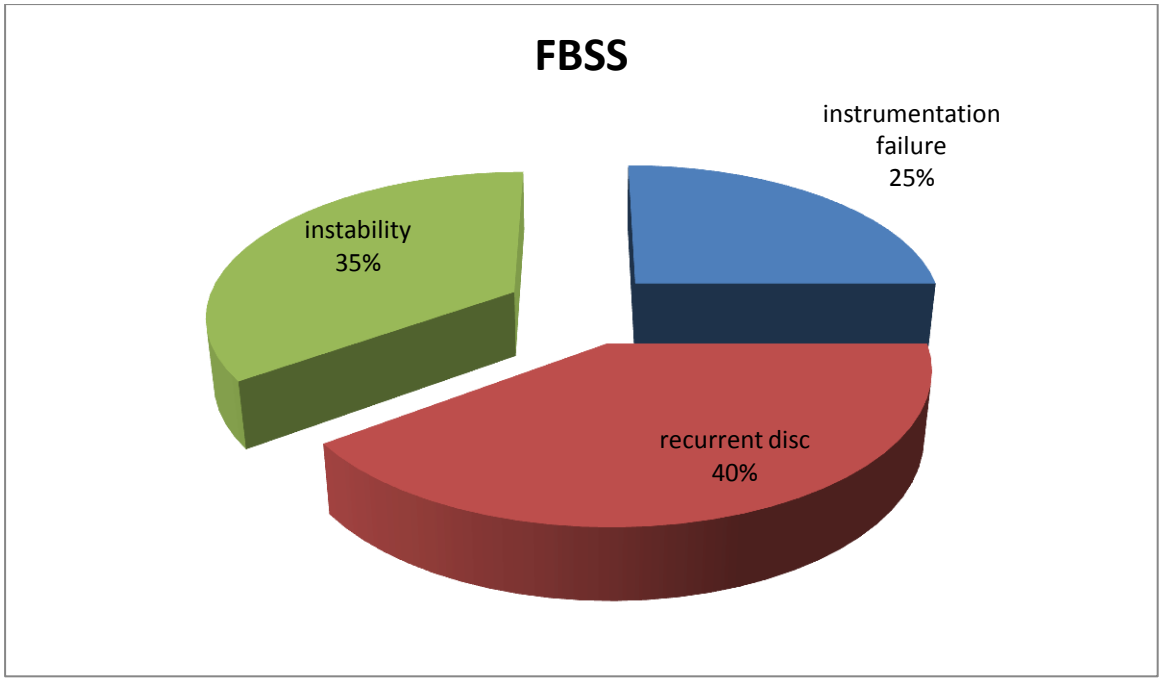
OBSERVATIONS

In our study, recurrent disc prolapse was the commonest cause of recurrent pain(40%). We encounter a female predominance in our study. The majority of patients have pain free interval more than 6 months. Most of the patients were between 35-50 yrs.

Causes of Recurrent pain:

S.No	Diagnosis	No. of cases	percentage
1	Instrumentation failure	5	25%
2	Recurrent disc prolapse	8	40%
3.	Instability	7	35%

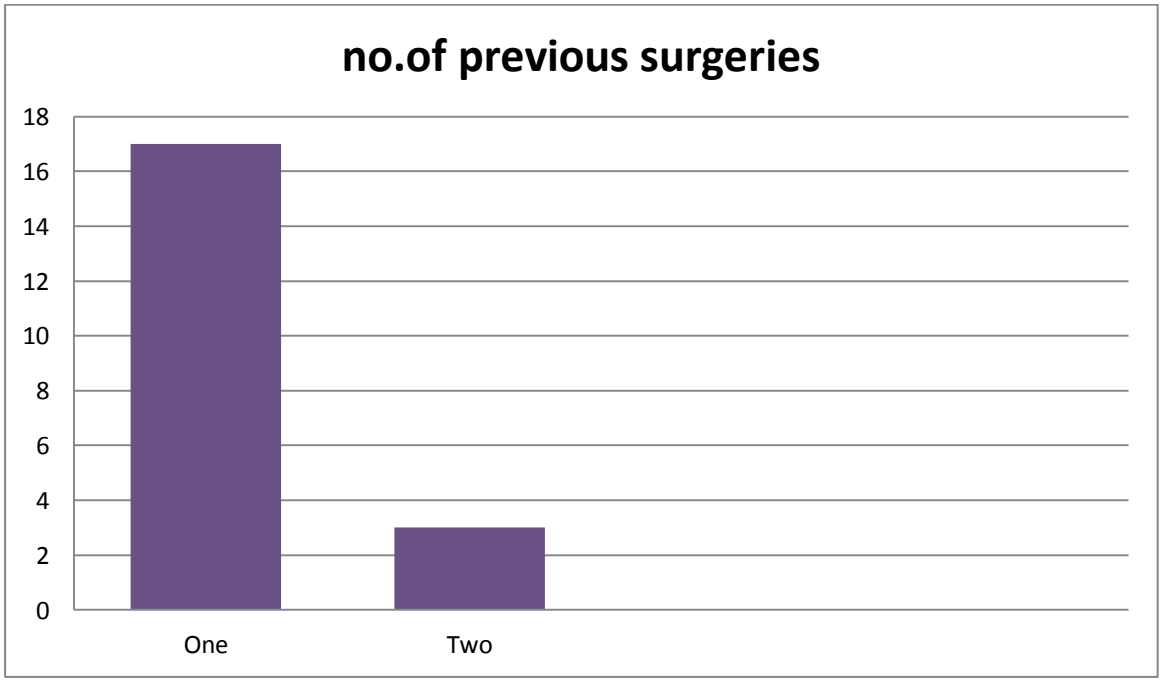




No of previous surgeries:

Operated once---17 patients

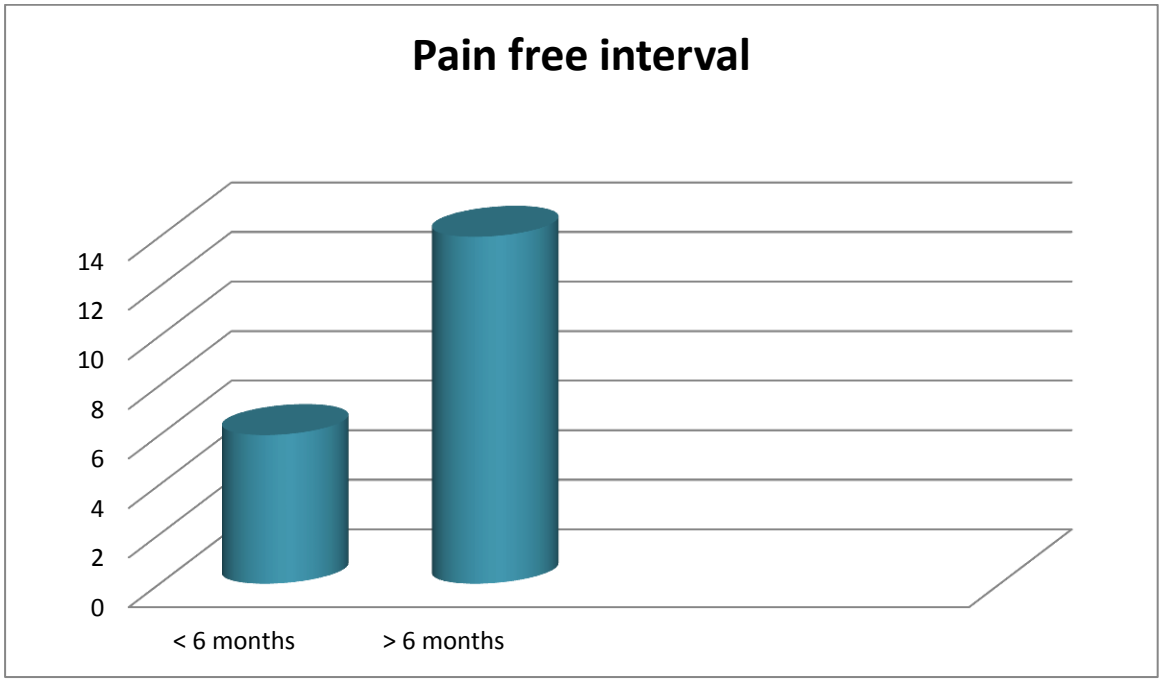
Operated twice--- 3 patients



Pain free interval:

Less than 6 months : 6 patients

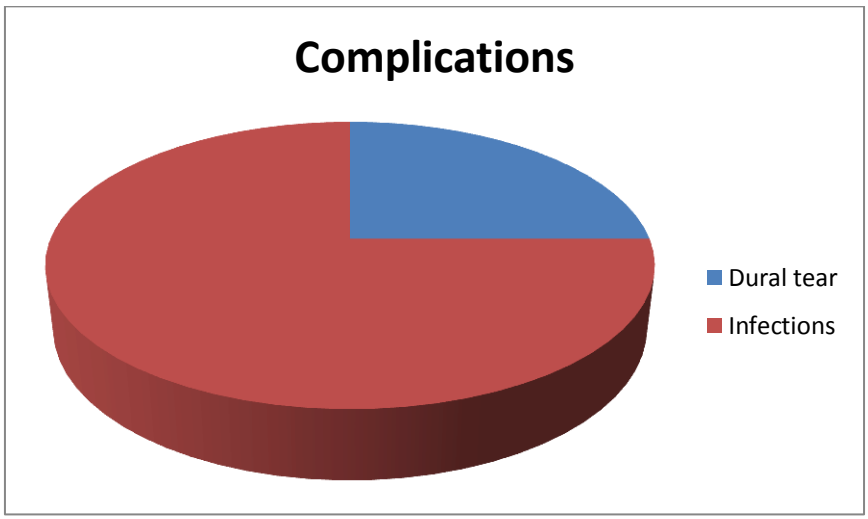
More than 6 months: 14 patients.



Complications:

In this study we had four patients with complications 20%.

Three patients had infections(15%) and one patient had dural tear (5%).



RESULTS

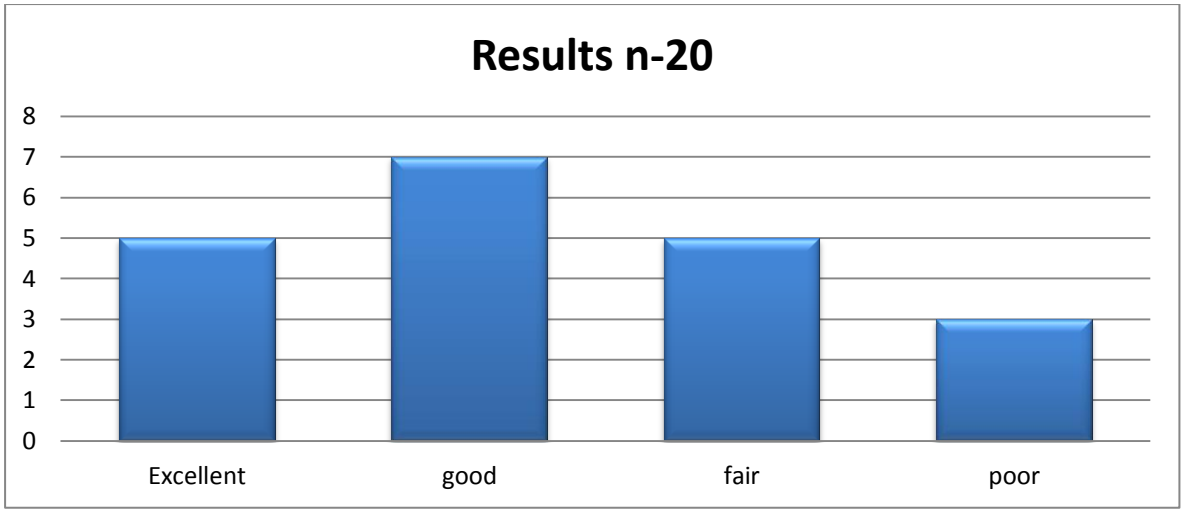
Patients were followed up regularly every 4th week for 6 months. During the follow up radiological, clinical and neurological evaluation were done. Patients were evaluated clinically by using Visual Analogue Scale, Oswestry Disability Index and ASIA score.

The results were classified as

Excellent	If the patient felt no pain,doesnot require any medication,and the patient returns to his or her original work.
Good	If the pain is much improved, requires little medication and returned to work
Fair	Pain improved moderately, requires frequent medication, changed to lighter work.
Poor	No improvement or even more pain, frequent medication, bed ridden most of the time

Results: success rate : **60%**

Total	Excellent	Good	Fair	Poor
20	5	7	5	3



Comparison between preoperative and postoperative ODI scores.

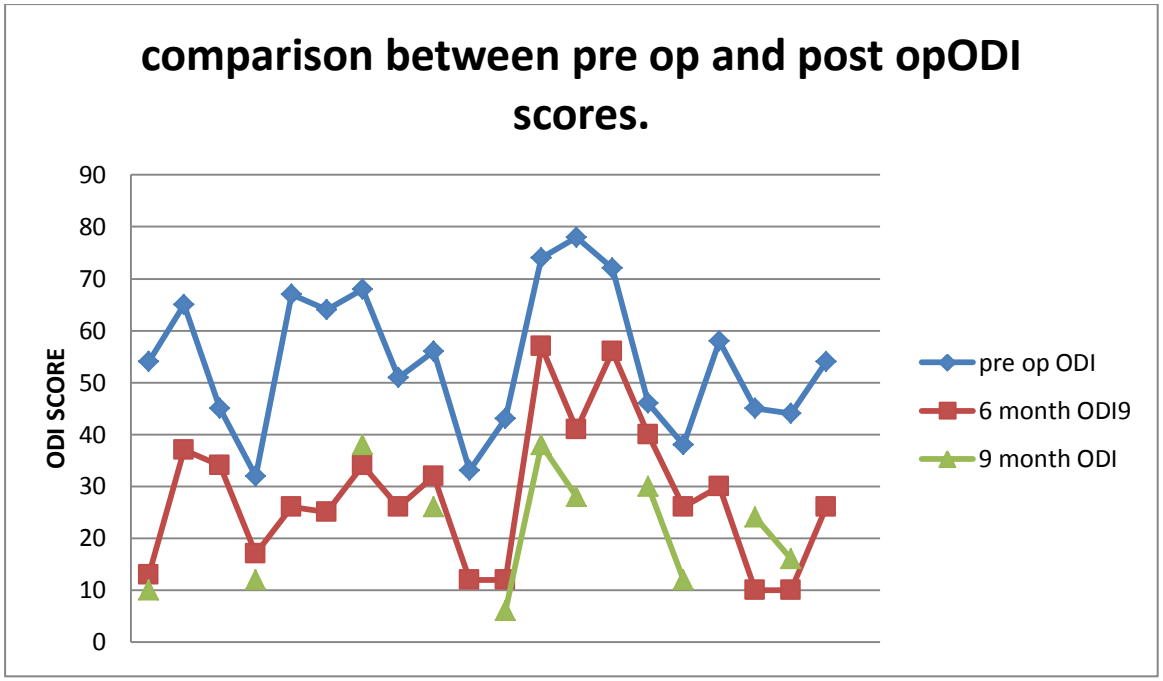
Mean preoperative ODI scores: 54.35

Mean postoperative ODI scores after 6 months : 28.2

Mean postoperative ODI scores after 9 months : 21.8

The comparison between the preoperative and postoperative ODI score gives a statistically significant favourable outcome.

T value -11.023 ; df 19 pvalue - < 0.000 (highly significant).



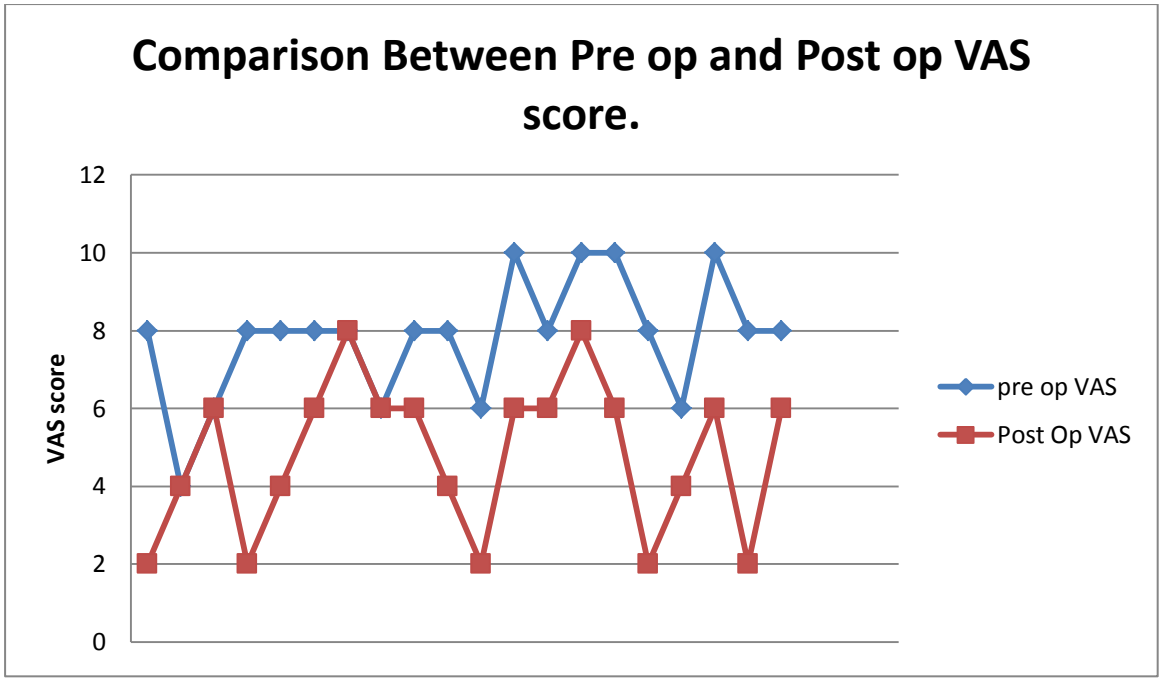
Comparison between preoperative VAS and Postoperative VAS score.

Mean preoperative VAS score : 7.8

Mean postoperative VAS score : 4.8

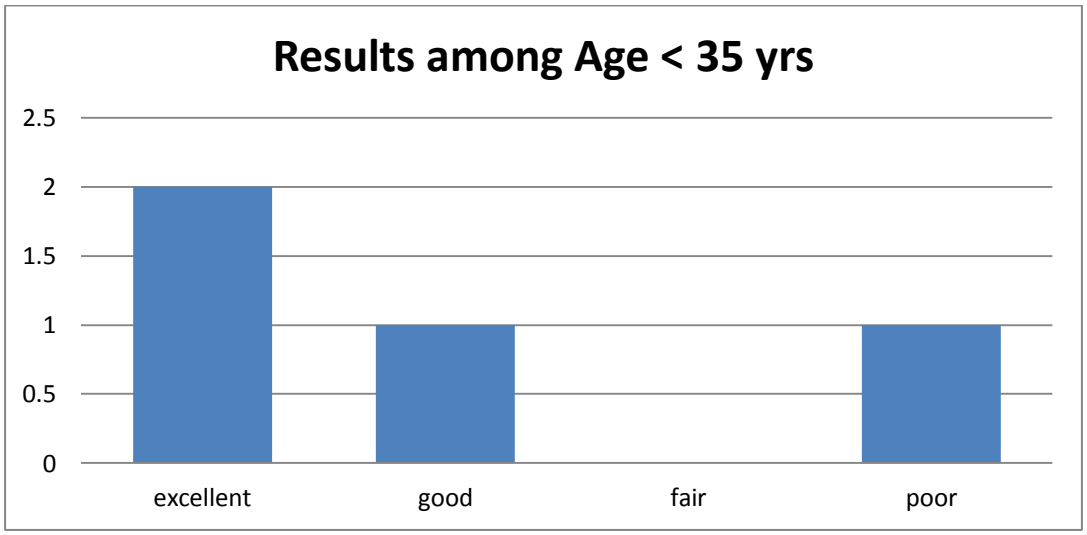
The comparison between the preoperative and the postoperative VAS score gives a statistically significant favourable outcome

VAS-Tvalue-6.381,df-19, p value- < 0.000 (highly significant)



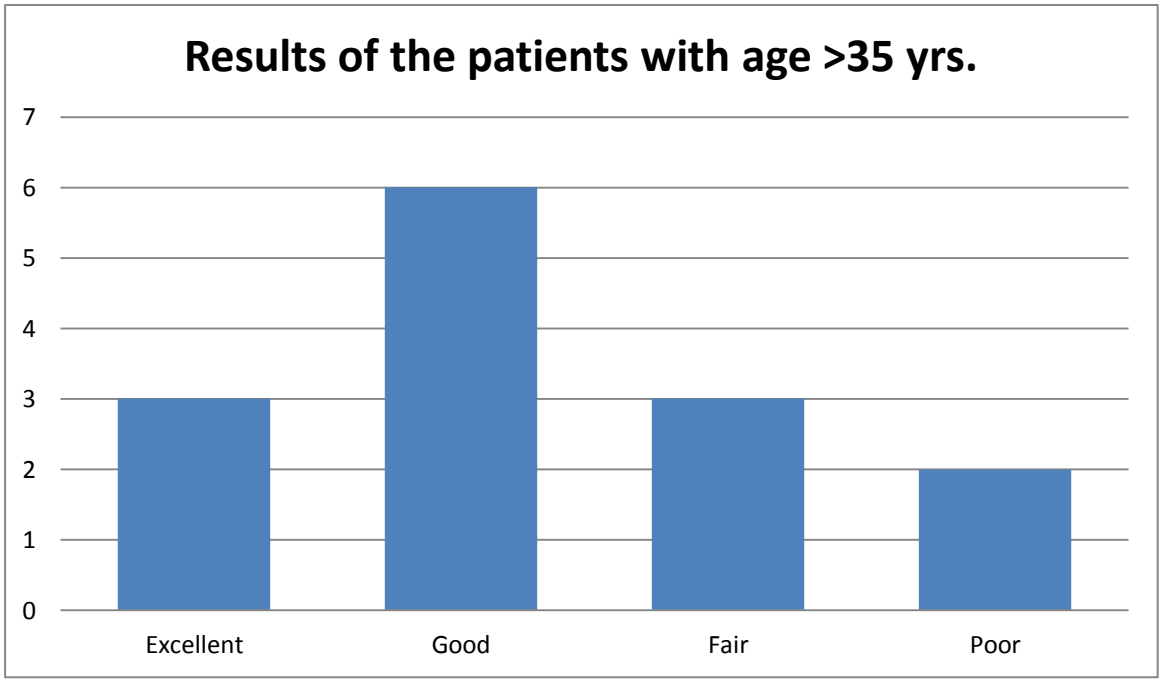
Results among young patients (< 35 yrs) success rate: **75%**

Total	Excellent	Good	Fair	Poor
4	2	1		1



Results among patients with age > 35 yrs: success rate**: 56.25%**

Total	Ecxellent	Good	Fair	Good
16	3	6	3	2

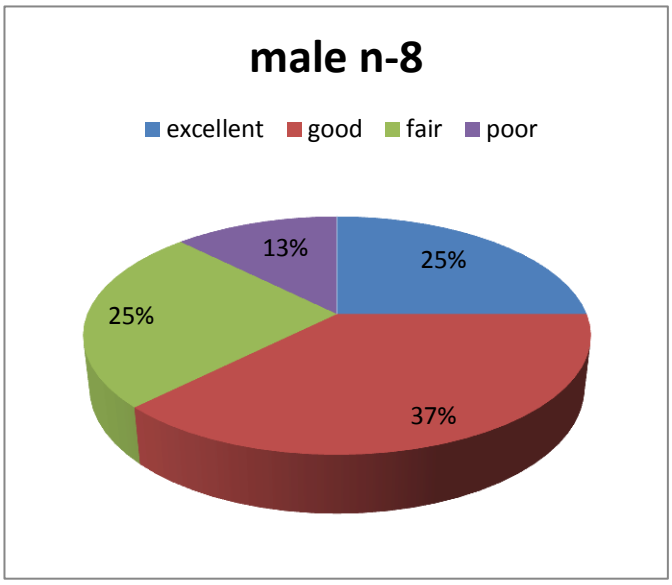


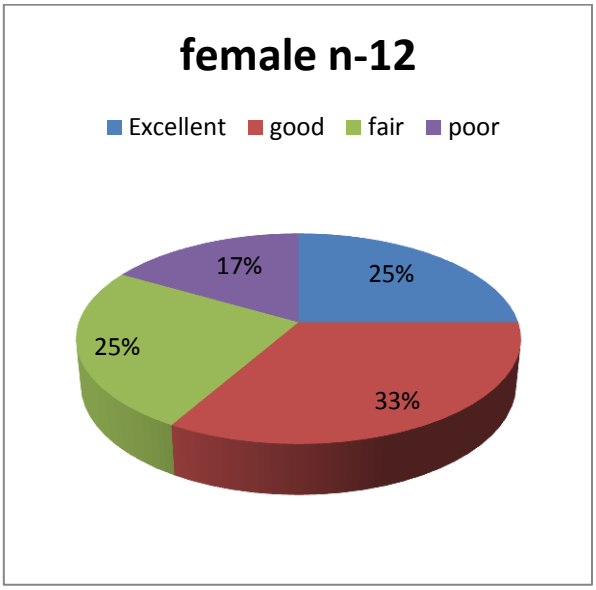
Results among male: success rate – **62.5%**

Total	Excellent	good	fair	poor
8	2	3	2	1

Results among Female: Success rate- **58.3%**

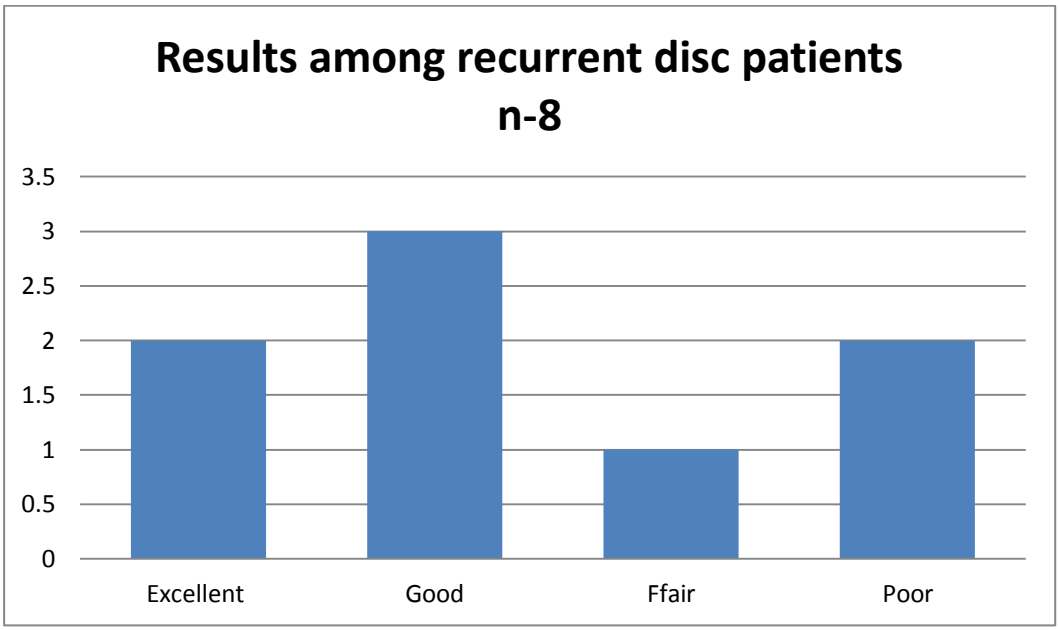
Total	Excellent	good	fair	poor
12	3	4	3	2

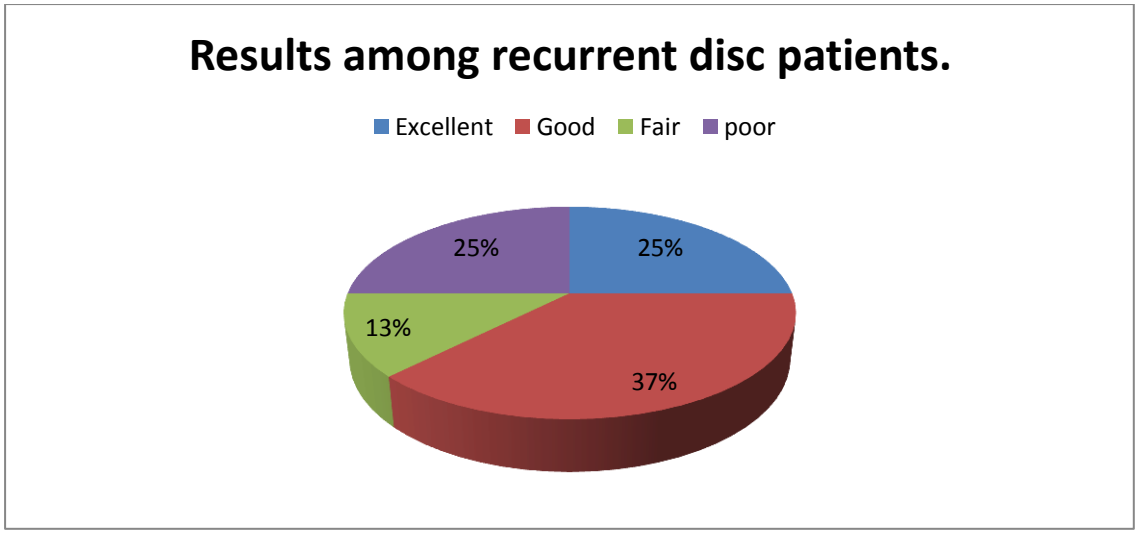




Results among the recurrent disc cases: success rate- **62.5%**

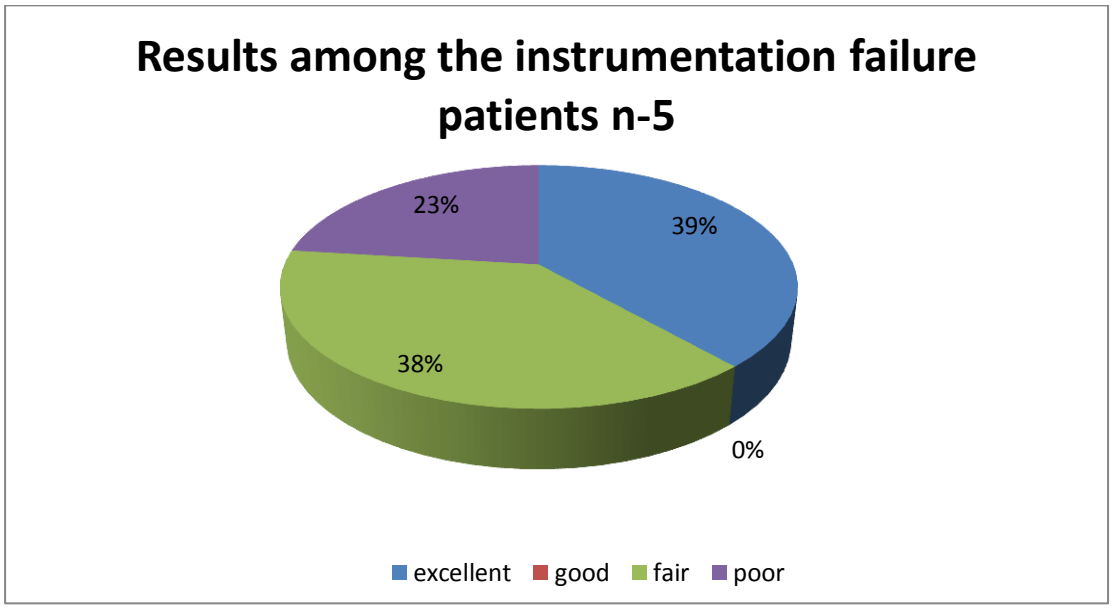
Total n	Excellent	Good	Fair	Poor
8	2	3	1	2

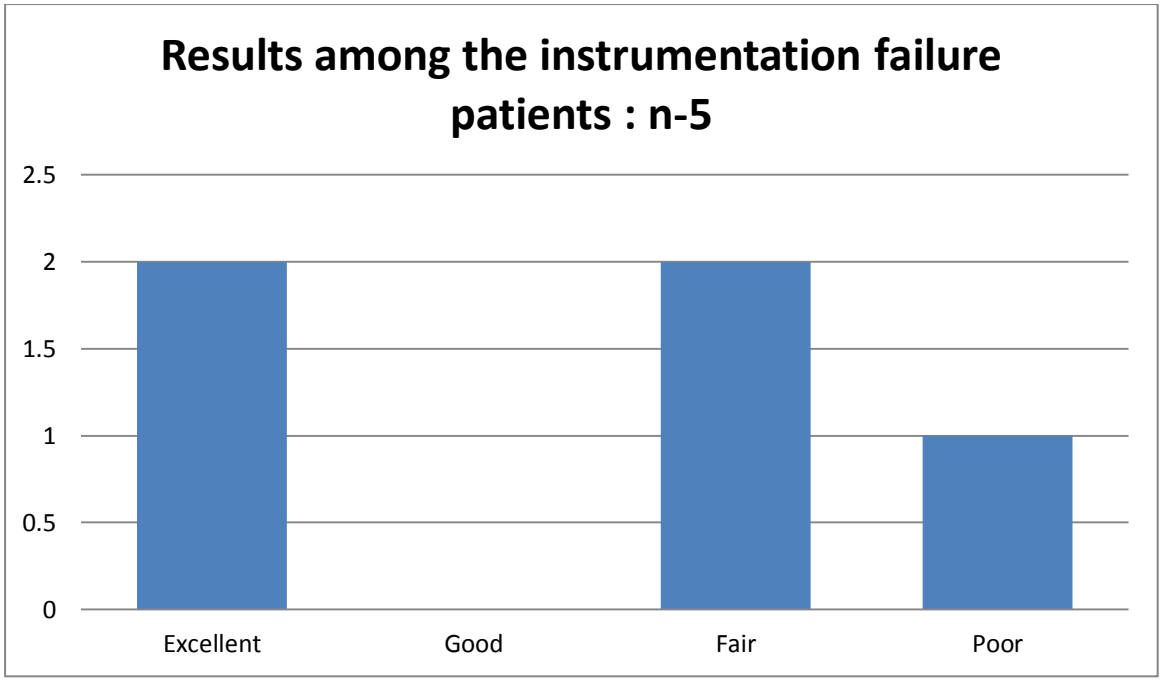




Results among the instrumentation failure cases: Success rate: **40%**

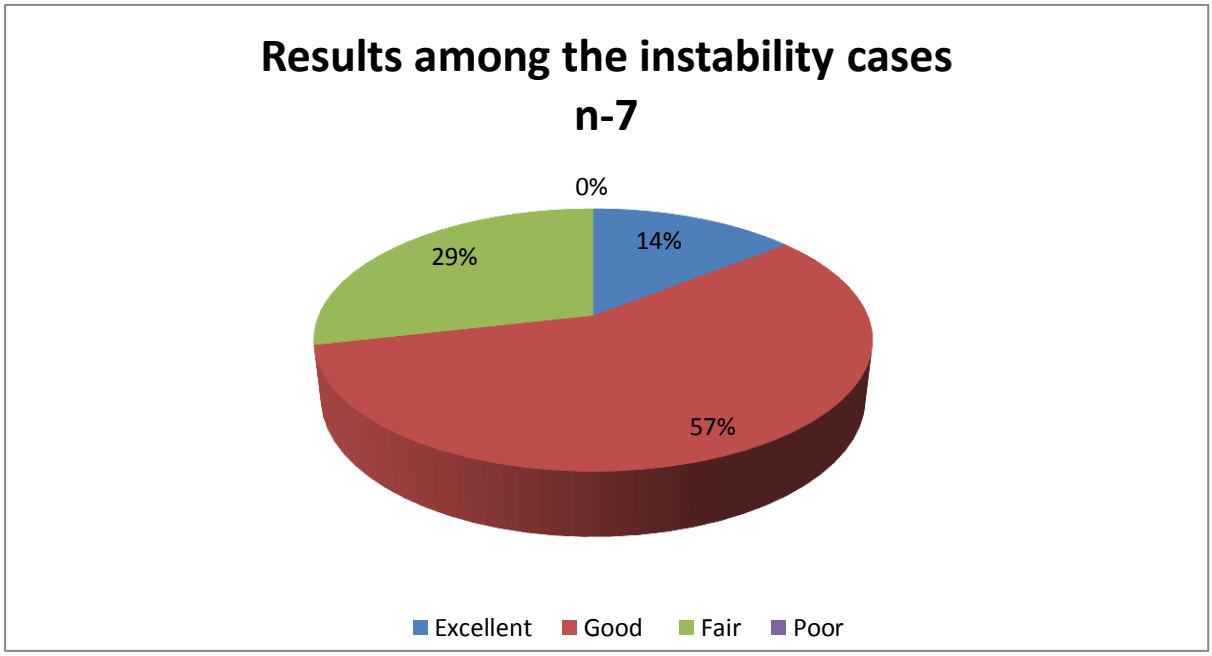
Total n	Excellent	Good	Fair	Poor
5	2	0	2	1

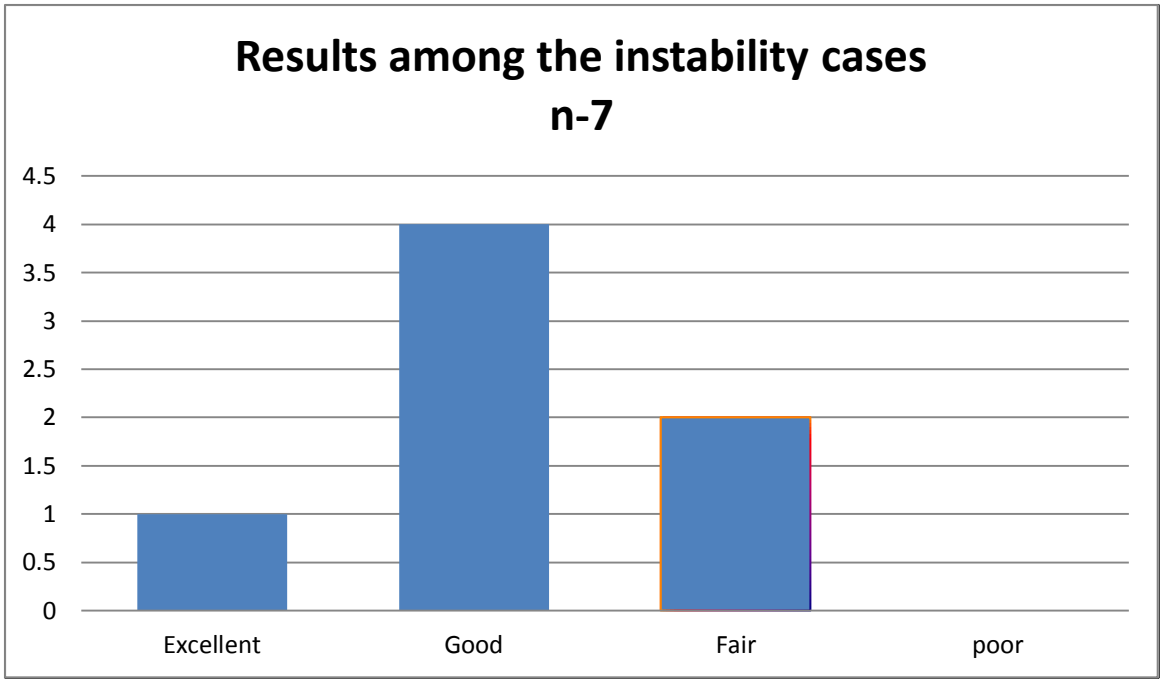




Results among the instability cases: Success rate **: 71.4%**

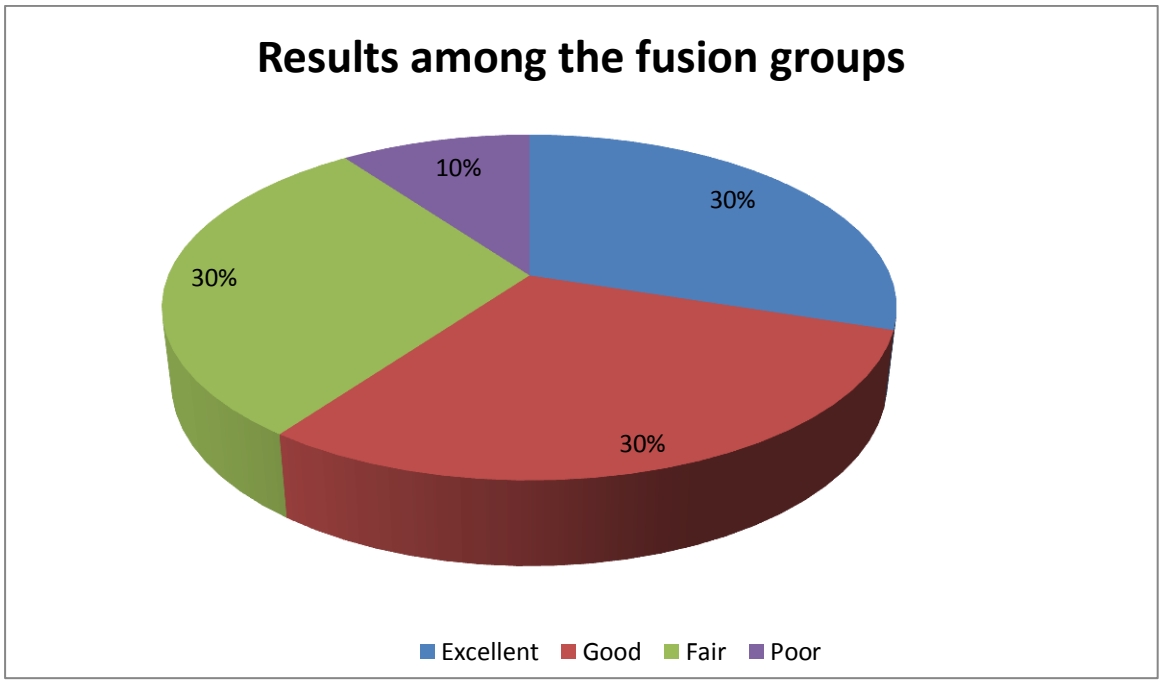
Total	Excellent	Good	Fair	Poor
7	1	4	2	0

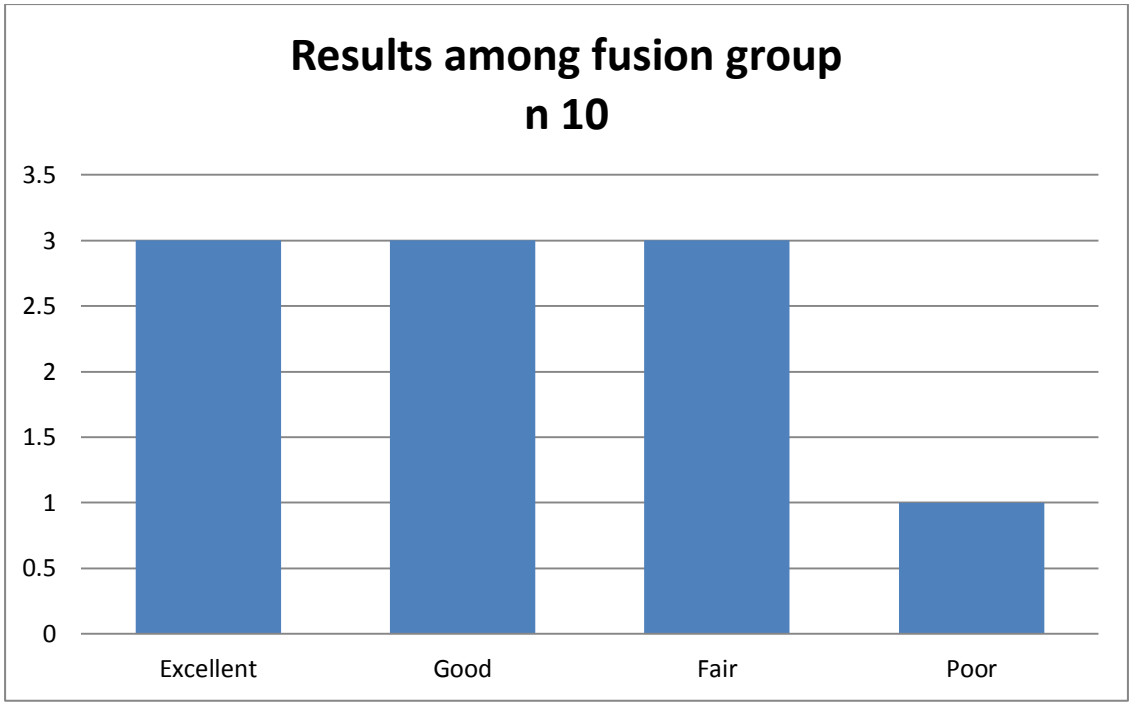




Results among the fusion group: Success rate: **60%**

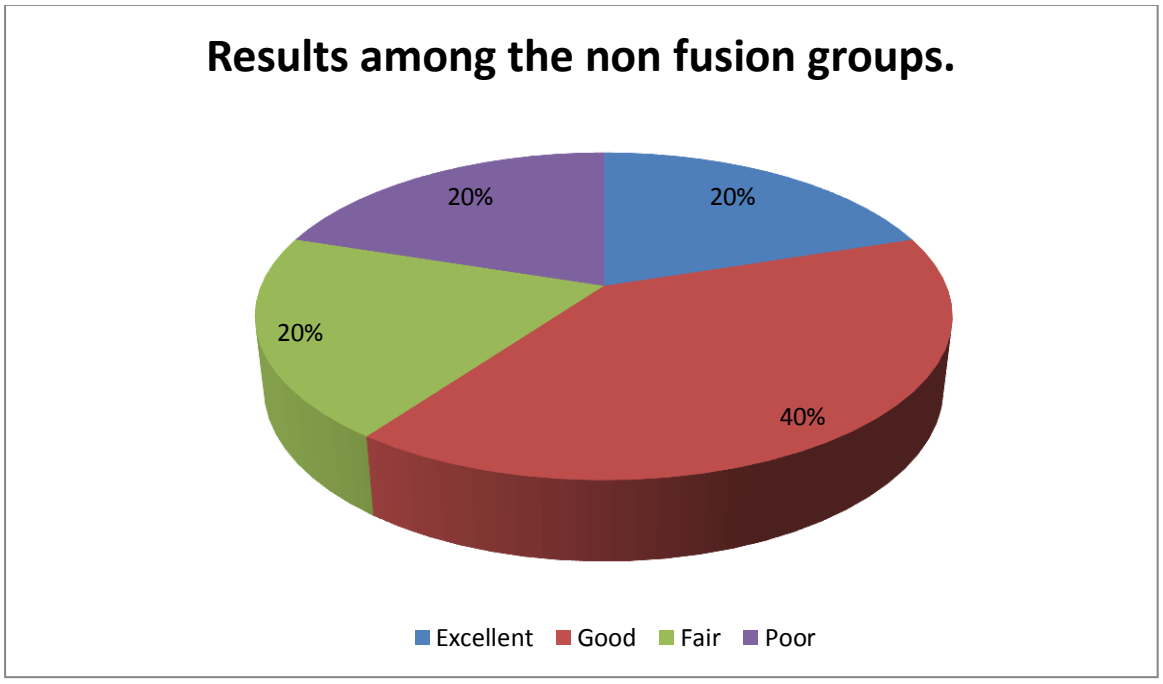
Total	Excellent	Good	Fair	poor
10	3	3	3	1

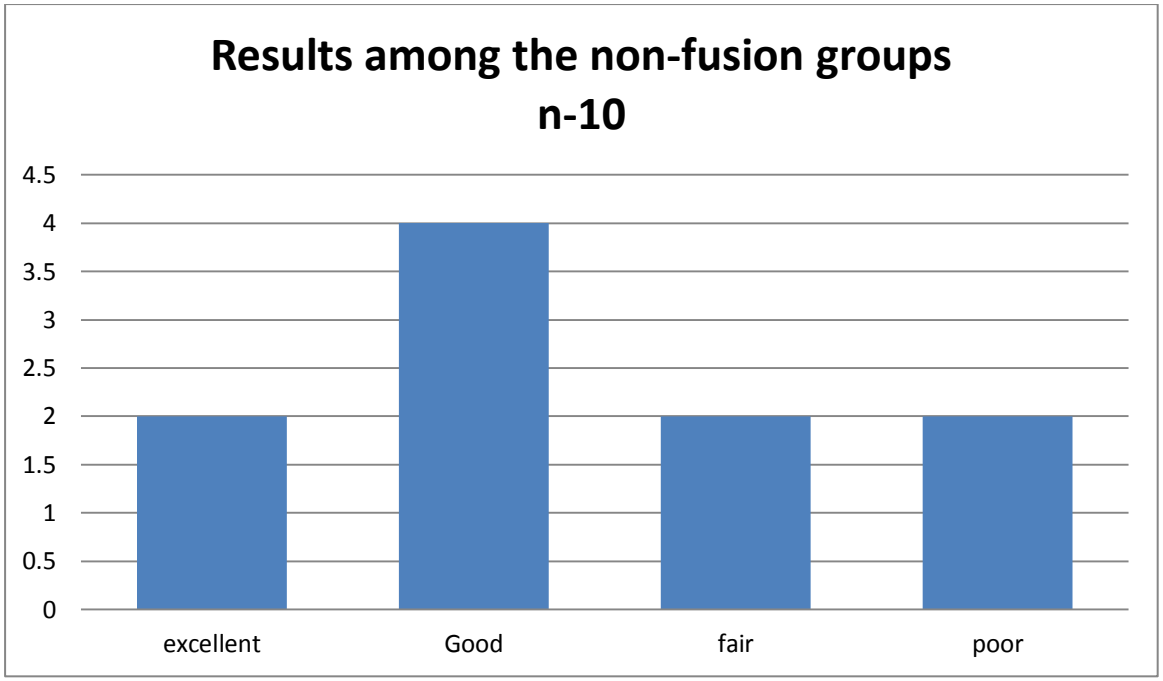




Results among non fusion groups: Success rate- **60%**

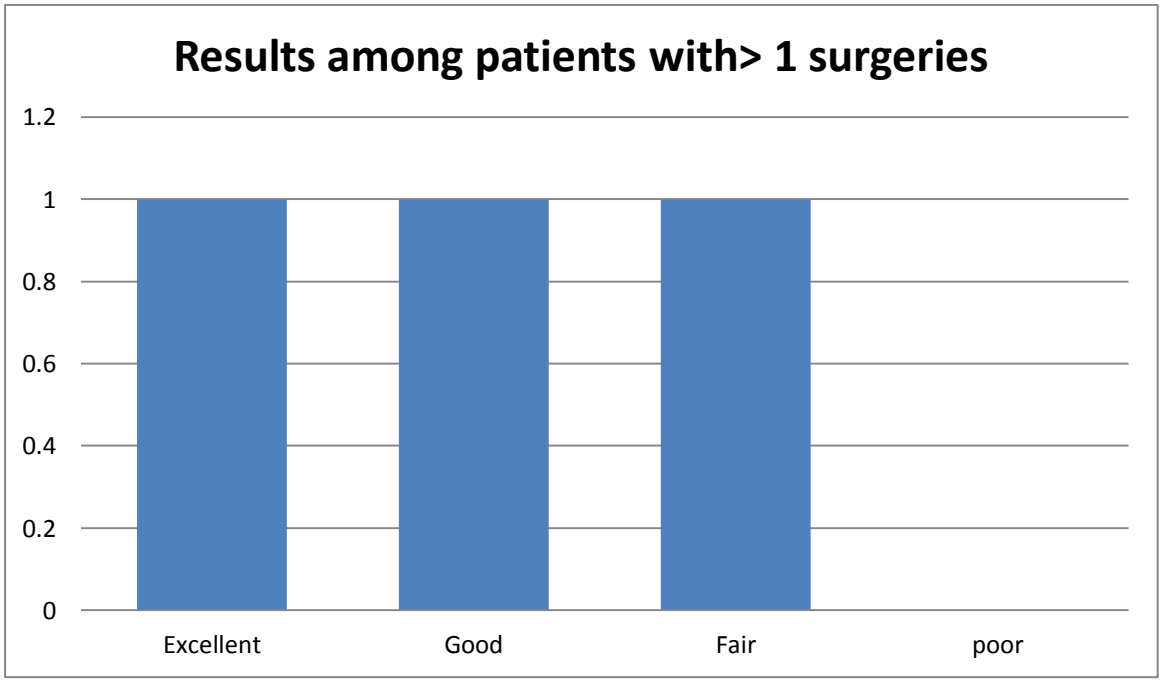
Total	Excellent	Good	fair	poor
10	2	4	2	2





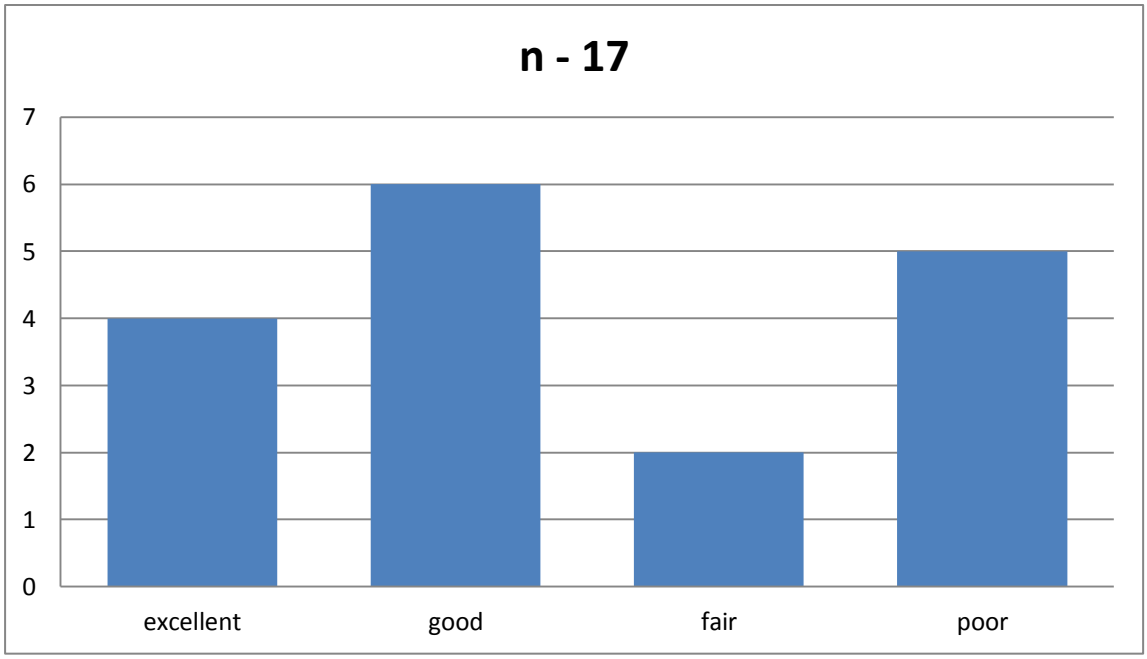
Results among patients with > 1 surgery: success rate; **66.6%**

Total	Excellent	Good	Fair	Poor
3	1	1	1	0



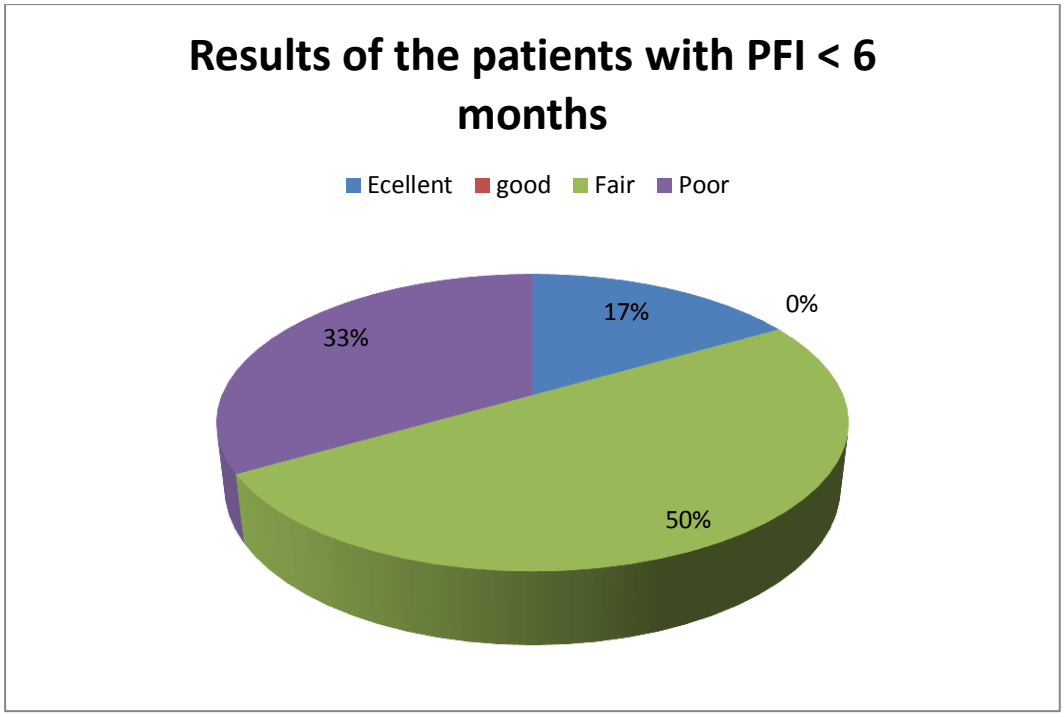
Results among patients operated once previously: success rate: **58.8%**

Total	Excellent	Good	Fair	Poor
17	4	6	2	5



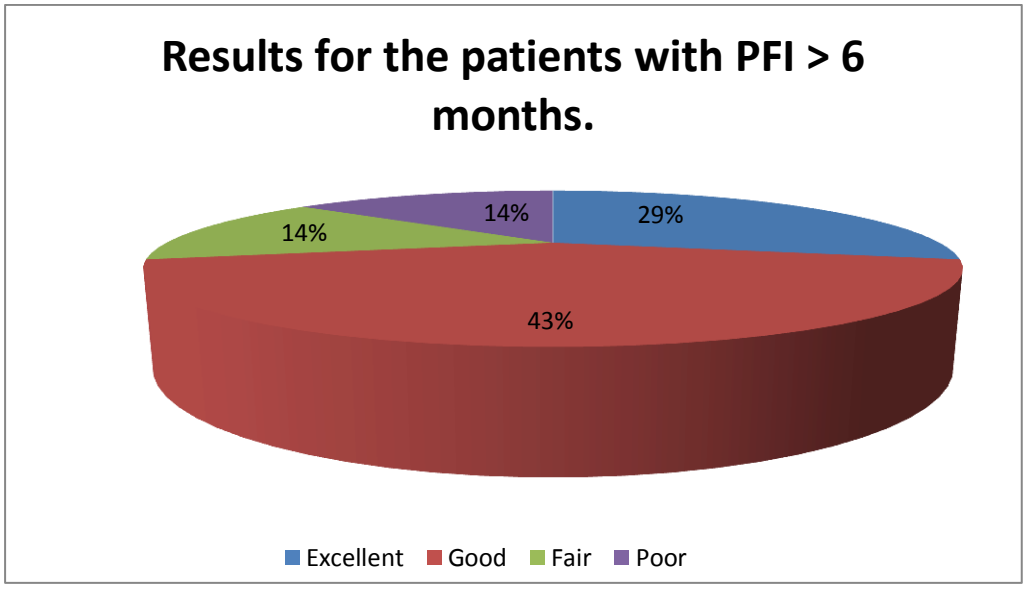
Results of the patients with pain free interval <6 months: success rate: **16.6%**

Total	Ecxellent	Good	Fair	Poor
6	1		3	2



Results of the patients with pain free interval > 6 months: Success rate: **71.4%**

Total	Excellent	Good	Fair	Poor
14	4	6	2	2



Factors	N	Success rate	p-value
Total	20	60%	
Age < 35 yrs >35 yrs	 4 16	 75% 56.3%	0.494
Gender Male Female	 8 12	 62.5% 58.3%	0.852
No.Previous surgery 1 >1	 17 3	 58.8% 66.6%	0.798
Pain free interval < 6 months >6months	 6 14	 16.6 % 71.4%	0.03
Fusion Yes no	 10 10	 60% 60%	1.000
ODI score			< 0.000
VAS score			< 0.000

DISCUSSION:

The outcome following revision surgery for failed back syndrome depends the pre evaluation, precise diagnosis, modality of treatment, pain free interval following the index surgery, number of previous operations, age , sex and finally the experience of the operating surgeon and pre-operative planning. The successful outcome following a revision surgery for the failed back syndrome ranges from 12-82%[76,77].

The operative criteria used for the primary spine surgeries may not be applicable to the revision surgery. Stewart et al[78] in his study concluded that there exists difference in the operative criteria, follow up criteria and criteria for success explaining why there is difference of opinion between the researchers on which factor favours successful outcome in failed back surgery syndrome.

In accordance with the existing literature the patients were evaluated preoperatively by X-rays of lumbosacral spine, flexion and extension lateral views, CT scan and MRI lumbosacral spine. Nineteen patients were operated through posterior approach and one through anterolateral approach. As majority of the failed back surgery patients are approached and operated posteriorly, there may be special situations where an anterior approach and surgery may be

indicated. Patients who require anterior reconstruction and augmentation to prevent failure of the posterior stabilisation procedure may be approached anteriorly.

Post operatively patients were followed up with the Oswestry disability index and the Visual Analogue Scale. The ultimate aim of the revision surgery is to achieve a pain free stable spine.

The mean age of presentation in our study was 41.15yrs(range from 23-60 yrs) compared to the mean age of 55.4 in Chak Bor Wang et al study. The male : female ratio in our study is 8:12.

The overall success rate in our study is 60% which is comparable to the similar studies like the study conducted by Chak Bor Wong et al[14],where the success rate was 83.9% and 72% in the study conducted by Stewart et al. The postoperative ODI score and VAS score compared to the Preoperative ODI and VAS score showed favourable outcome which is statistically significant (VAS- Tvalue-6.381,df-19, p value- < 0.000 & ODI score- T-value- 11.023, df-19,p value- < 0.000).

S.no	Study	Success rate
1.	Chak Bor Wong et al	83.9
2.	Stewart et al	72%
3.	Our study (MMC)	60%

	Mean Pre op Score	Mean Post op Score	pvalue
Visual Analoge score	7.8 (±sd 2.1)	4.8	< 0.000
Oswestry disability score	54.35 (±sd 10.6)	28.2	< 0.000

The independent factors like age, sex may affect the outcome of the revision surgeries. North et al and Stewart et al concluded that younger patients have better outcome following the revision surgery compared to the elderly age group[77-79]. However Fritsch et al stated that there is no difference in the outcome following revision surgery based on the gender and age.

In our study younger patients (< 35 yrs) had very good outcome of 75% compared to the older age group (> 35 yrs) in which the outcome was 56.3% This difference may be due to the on going degenerative changes in the spine as age increases or may be due to the higher compliance of the younger individuals for the postoperative rehabilitation[80]. But we could not find any statistical significance (chisquare value of 0.469, df-1,pvalue -0.494).

s.no	Study	Male	Female
1.	Stewart et al	27	12
2.	Chak Bor Wong et al	45	79
3.	Our study	8	12

In our study there is a marginal increase in the successful outcome in male patients (62.5%) compared to the female patients (58.3%). However these observations were not statistically significant. (chi square 0.035, df-1,pvalue – 0.852).

The most common cause of Failed back syndrome we encounter in our study was the recurrent disc herniations(40%), compared to 20% in Stewart et al study and 22.% in Chak Bor Wang et al study.

	Our study	Stewart et al	Chak Bok wang et al
Recurrent disc herniations	40%	20%	22.5%
Post laminectomy instability	35%	30.7%	24.1%
Instrumentation failure	25%	20.5%	13.7%

Waddell et al in his study stated that probability of successful outcome decreases with the number of surgeries performed. Kim et al showed in his study that about 66% of success for revision surgeries and 55% in re revision surgery. In our study the average previous surgery is1.13 compared to 1.3 in Stewart et al study. We in this study found that in patients with more than one previous surgery had better outcome which is in contrast to the previous studies

but the results were not statistically significant (Chi square value-0.065, df-1,p value-0.798).

The average pain free interval in our study is 30.95 (0-156 months)

s.no	Study	Average Pain free interval
1.	Our study (MMC study)	30.95 months
2	Stewart et al	20 months
3.	Chak Bor Wong et al	39.6months

Finnegan et al concluded that the patients with pain free interval < 12 months will have extensive fibrosis than patients with pain free interval > 12 months who may have other reasons for pain. Biondi et al and Waddell et al also in their studies showed that the patients with pain free interval > 6 months will have better outcome than the patients with pain free interval <6 months. In the study conducted by Chak Bor Wong et al patients with PFI >6 months had better results than the patients with PFI with< 6 months but there was no statistical significance in this observation. In our study also we experienced a similar results with a success rate of 71.4% in patients with PFI > 6months and 16.6% in patients with PFI < 6 months which is statistically significant with p value of 0.03(Chi square- 4.432, df- 1).

Study	Outcome with PFI < 6 month	Outcome with PFI > 6 month	p value
Our study (MMC)	16.6%	71.4 %	0.03
Chak Bor Wang et al	76 %	88%	0.39

In this study there were five patients with neurological deficit during the revision surgery. One patient had fracture L3 vertebra with grade 3 motor power, for whom anterior stabilisation was done. The patient improved to grade 5 motor power in 8 months follow up period. Another patient who sustained paraparesis grade 1 motor power following the index procedure due to the aberrant screw placement within the canal , for whom revision surgery was done and recovery from grade 1 to grade 3 motor power in 6 months follow up period was observed.

The patient who had TLIF cage failure and developed EHL and FHL weakness(grade 3/5) recovered following the revision surgery (EHL- 4/5 and FHL -5/5). The other two patients who had recurrent disc with weakness, who recovered completely following the revision surgery. Overall outcome in these patients however is 40%. This is attributed to the poor activity level following the revision surgery because of the neurological deficit. In other words, the positive outcome for the patients with no neurological deficit were successfully predicted. Although we experience a poor outcome in all these patients, there

was some recovery in the motor power (ASIA scale) and at long term follow up have better outcome.

Kim et al in his study revealed that the results for recurrent disc diseases were better than the stenosis patients[14]. Finnegan et al stated that the outcome of revision surgery is better in mechanical compression like recurrent disc disease and dynamic instability. Chak Bor wong also experienced a similar results with good functional outcome for recurrent disc diseases(78.6%), Instability(93.32%), and pseudoarthroses (94%). We in our study also experienced a similar kind of result with a successful outcome of 71.14% in instability cases, 62.5% outcome in recurrent disc cases, and 40% in the instrumentation failure cases. The good functional outcome in the instability cases is mainly attributed to the spinal fusion which is achieved either through an instrumentation or through the posterolateral bone grafting. The poor outcome following the revision surgery for the instrumentation failure may be attributed to the neurological deficit among two of the three patients which affects the activity level of the patient and infection in one patient which increases the morbidity.

FBSS	Outcome in our study (MMC) Total n-20	Outcome in Chak Bor wong et al study Total n-124
Recurrent disc diseases	62.5%	78.6%
Instability	71.14%	93.3%
Instrumentation failure	40%	94.5 %

After the laminectomy and discectomy the disc height may get reduced and produces a compressive load on the posterior elements or the radial bulge may produce nerve tissue tension. Cinnoti et al revealed that spinal fusion is not necessary in revision surgery for recurrent disc disease.

But Fritsch et al in his study stated that patients with spinal fusion for recurrent disease experienced a better outcome compared with the patients without fusion. The laminectomy and discectomy done in the index procedure produces instability and pain and causes continuous epidural and nerve irritation and produces epidural fibrosis. In this study(MMC) we have done fusion for 5 of the 7 instability patients of which 4 patients had good outcome.

Out of eight recurrent disc patients fusion was done in only 2 patients but still we obtained a good functional outcome of 62.5%. One of our patients with L5 S1 recurrent disc disease with pain free interval 10 years has had laminectomy and discectomy done. During the initial follow up period she had a better outcome but as the follow up period increased the ODI score increased

indicating disability. This is due to the instability at the L5-S1 level during 48 months of follow up. Therefore we conclude that the successful outcome in the nonfusion group may be due to the short term follow up, which needs further long term follow up to decide. And in our study there is no statistical significance between the fusion and nonfusion groups (chi square test- 0.000 df-1 ,p value 1.000).

Complications:

Dural tear :

One of the commonest complications in revision surgeries for failed back surgery syndrome The incidence of dural tear after revision surgery is 11% compared to 2.8% in primary discectomy. In our study we encounter a case of dural tear (5%).

The incidence of dural tear increases as the number of surgery increases. As the surgery is nearing the spinal cord, dura gets torn by a bone bitting instrument trying to remove adhering scar tissue.

Infections:

In this study we had 3 cases of infection (15 %). There is increased incidence of infection following revision surgery for failed back surgery syndrome.This may be due to the scar tissue formation following the repeated

surgeries, extensive dissection during the surgery and hematoma collection in the resultant dead space. These patients recovered after the wound wash and appropriate iv antibiotics. Where ever necessary implant exit is required to control infection.

CONCLUSION:

Proper preoperative evaluation and diagnosis is of paramount importance in the management of failed back surgery syndrome.

High success rate following the revision lumbar surgery depends on good preoperative planning .

Finding out the specific pathology and targeting it appropriately leads to gratifying results.

Good experience and expertise in meticulous dissection prevents complications like dural tears and infections.

Spinal fusion is mandatory in cases of postlaminectomy instability, and recurrent disc prolapse with demonstrable instability.

The experience of the operating surgeon in dealing with failed back surgery syndrome patients influences the final outcome.

For the successful outcome of the revision surgery for failed back syndrome spinal fusion is compelling. However a long term follow up and a larger sample study is needed to further validate our findings.

CASE ILLUSTRATION:

Case 1:

Balakrishnan 23 /m Ip.No101702

Diagnosis: L4 –L5 spondylolisthesis posterior stabilisation and TLIF done with instrumentation failure (Cage failure)

Procedure done:

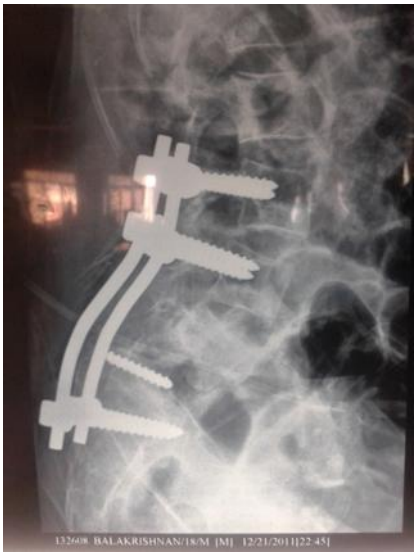
Implant exit and revision posterior stabilisation with postero-lateral bongrafting

Complication: Dural tear

Pre op

Post op -

6 months follow up



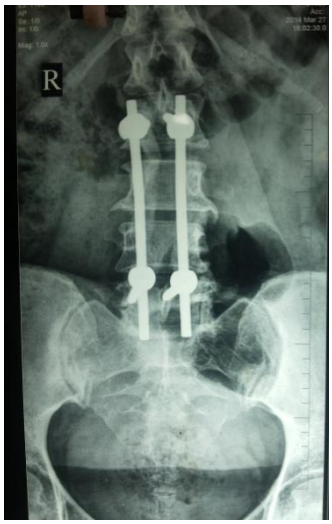
Follow up case 1: Balakrishnan

Case 2: Indira 45/f Ip no 23490

Diagnosis : Aberrant screw fixation post L3L4 discectomy.

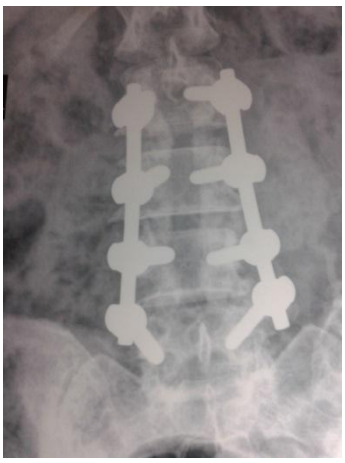
Procedure done: Revision posterior stabilisation

Patient developed paraparesis following the index procedure who recovered following the revision.

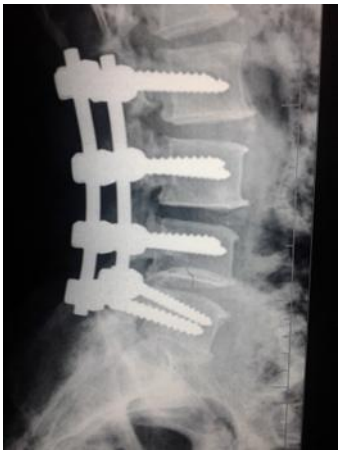


:

Post op



6 months follow up:

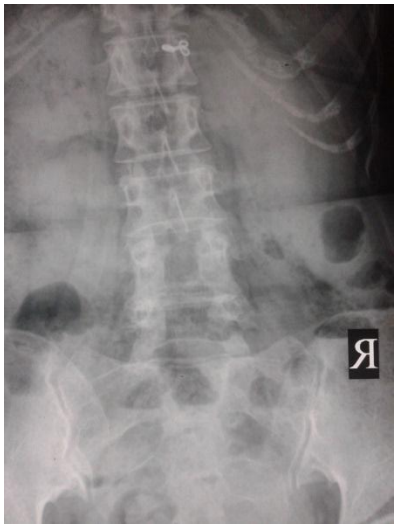


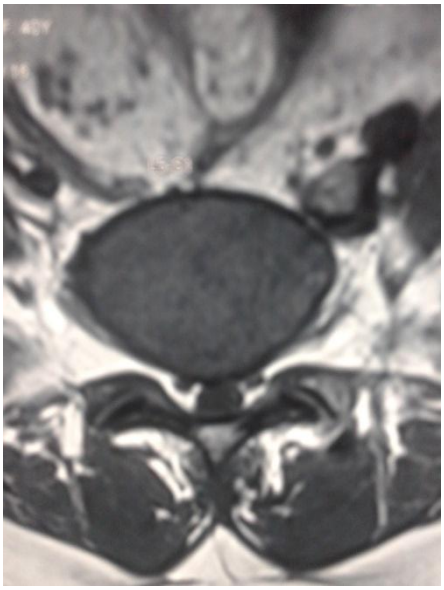
Case 3 : Soundari 43/F Ip no.15789

Diaagnosis: Recurrent disc prolapse L4L5 disc disease

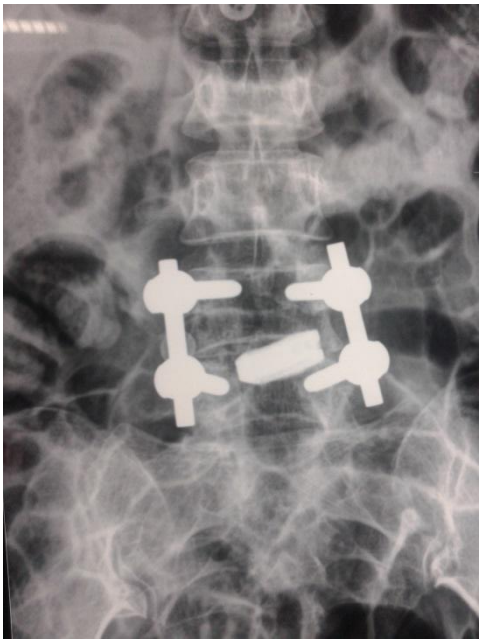
Procedure done : Rediscectomy and TLIF

Pre op:

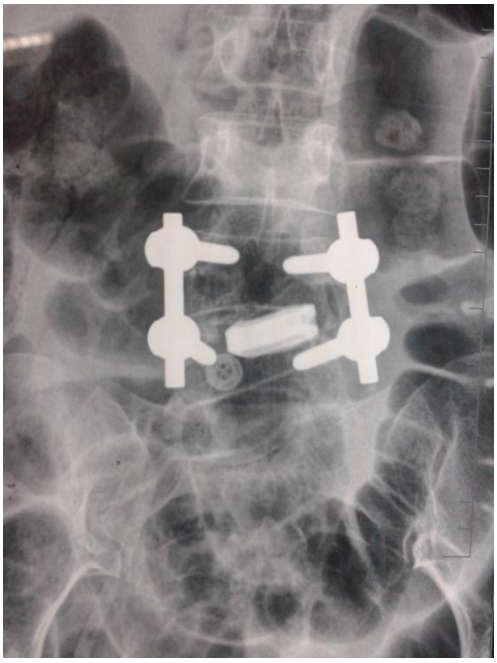




Post op



6 month follow up:



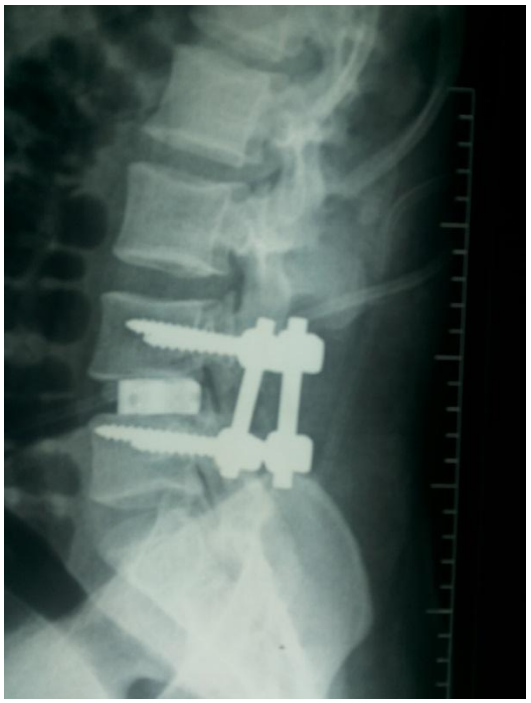
Case 4: Nevilraj 25/M Ip no: 99443

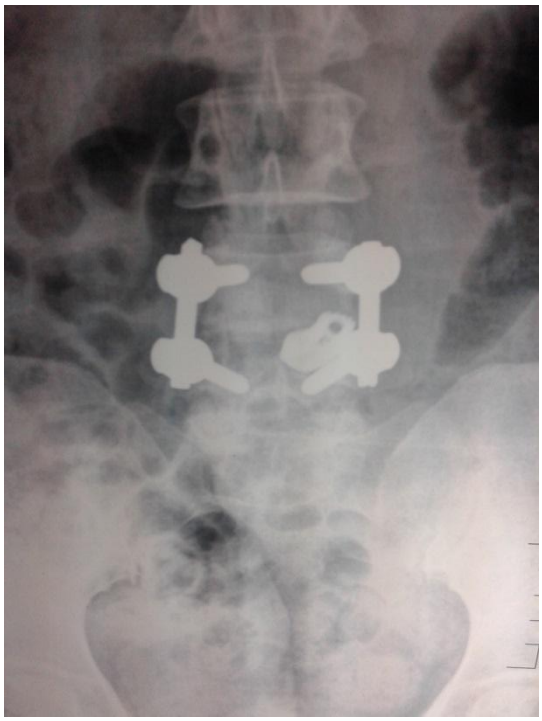
Diagnosis : Post laminectomy Instability L4 L5

Treatment: Posterior stabilisation with transforaminal lumbar interbody fusion.

Pre op:

6 months follow up.





ANNEXURE

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A RETROSPECTIVE AND PROSPECTIVE ANALYSIS OF FUNCTIONAL OUTCOME OF REVISION LUMBAR SURGERY FOR FAILED BACK SURGERY SYNDROME.

PROFORMA

Name : Age: Sex:

Address : Occupation:

History:

Back pain:

Leg pain:

Date of previous surgery:

Pain free interval:

Number of previous surgeries:

Frequency of medication:

Working status:

Bowel Bladder disturbances.

General Examination:

Co-morbidity:

Local Examination:

Straight leg raising test.

Tension Sign.

Neurological examination :

Sensory examination

Motor examination

Reflexes

Bladder and bowel status.

Radiological Survey:

Plain X ray Lumbosacral Spine

X ray Lumbosacral spine flexion and extension lateral views.

CT scan with myelogram

MRI Lumbosacral Spine

Preoperative Visual Analoge Scale:

Oswestry Disability Index:

Operation:

Approach:

Implants used:

Decompression:

Posterolateral fusion or interbody fusion:

Scar tissue:

Intra operative Complications:

Blood loss :

Post op Protocol:

Drain Removal :

Two hourly log rolling:

Post op rehabilitation:

Suture Removal:

Date of Discharge:

Follow Up:

Follow up period:

Wound status:

Back pain

Leg pain

Neurological examination

Postoperative ODI Score:

Postoperative VAS Score:

Excellent	If the patient felt no pain,doesnot require any medication,and the patient returns to his or her original work.
Good	If the pain is much improved, requires little medication and returned to work
Fair	Pain improved moderately, requires frequent medication, changed to lighter work.
Poor	No improvement or even more pain, frequent medication, bed ridden most of the time

PATIENT CONSENT FORM

Study Detail	:	**"A retrospective and prospective analysis of functional outcome of revision lumbar surgery for failed back surgery syndrome"**
Study Centre	:	Rajiv Gandhi Government General Hospital, Chennai.
Patient's Name	:	
Patient's Age	:	
Identification Number	:	

Patient may check (√) these boxes

a) I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction. ☐

b) I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected. ☐

c) I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ☐

d) I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or wellbeing or any unexpected or unusual symptoms. ☐

e) I hereby consent to participate in this study. ☐

f) I hereby give permission to undergo detailed clinical examination, Radiographs & blood investigations as required. ☐

Signature/thumb impression

Signature of Investigator

Patient's name and Address

Study Investigator's Name:
Dr. R.NEELAKANNAN.

ABBREVATIONS

FBSS – FAILED BACK SURGERY SYNDROME

IAR – INSTANTANEOUS AXIS OF ROTATION

PFI – PAIN FREE INTERVAL.

ODI – OSWESTRY DISABILITY INDEX.

VAS – VISUAL ANALOGUE SCORE.

MASTER CHART

S. No	Name	Age/sex	Ip. No	Diagnosis	Treatment	Pain Free interval	No. of previous surgeries	Pre op & Follow up ODI score				VAS		Pre-op ASIA score	Post op ASIA score		outcome	Follow up	Complications
								Pre op	6 m	9m	Final				0m	6m			
1	Dhanalaxmi	24/F	50546	L4 Potts spine posterior stabilisation done.with Implant failure	Implant exit done and Redo posterior stabilisation	2 months	1	54	13	10	10	8	2	5/5	5/5	5/5	Excellent	14 months	-
2.	Indira	45/F	23490	L3 L4 Disc disease posterior stabilisation done with paraparesis	Redo posterior stabilisation.L2L3L4 L5	0 days	1	65	37			4	4	Grade 1/5	1/5	3/5	poor	6 months	-
3	Mary	60/F	1314	L4L5 discectomy with instability	Posterior stabilisation with TLIF	6 months	1	45	34			6	6	5/5	5/5	5/5	fair	7 months	-
4.	Mohana	42/F	116384	L5S1 listhesis with implant failure and instability	Implant exit and redo posterior stabilisation and TLIF fusion	2 yrs	1	32	17	12		8	2	5/5	5/5	5/5	good	8 months	-
5.	Munusamy	45/m	23490/14	L3L4;L4L5;L5S1 disc disease L4 L5 laminectomy and discectomy done	Posterior stabilisation	1 yr	1	67	26			8	4	5/5	5/5	5/5	good	4 months	-
6.	Muruganandam	38/M	27239	L3 Fracture posterior stabilisation done with collapse	Anterior stabilisation with cage	6 months	1	64	25			8	6	3/5	5/	5/5	fair	8months	-
7.	Periasamy	43M	62704	Post discectomy L1-L2 level with L2-L3 spinal canal stenosis	Decompression and posterior stabilisation	3 months	1	68	34	38	64	8	8	4/5	4	4/5-EHL	poor	12 months	-
8	Pushpavalli	43/F.	1690	L4L5 discectomy with instability	Posterior stabilisation done, Implant exit done	6 months	2	51	26			6	6	5/5	5/5	5/5	fair	6 months	-

S. No	Name	Age/sex	Ip. No	Diagnosis	Treatment	Pain Free interval	No. of previous surgeries	Pre op & Follow up ODI score				VAS		Pre-op ASIA score	Post op ASIA score		outcome	Follow up	Complications
								Pre op	6 m	9m	Final				0m	6m			
9	Fazal Ahmed	52/M	60903	L4L5 recurrent disc disease	Redo discectomy	5 yrs	1	56	32	26	24	8	6	4/5	5/5	5/5	good	36 months	-
10	Soundari	43/F	15789	Recurrent Disc prolapse L4 L5 level	Discectomy posterior stabilisation and fusion with TLIF	1 yr	1	33	12			8	4	5/5	5/5	5/5	excellent	7 months	-
11	Zarina	40 /F	103956	Recurrent disc L4L5 level alredy L4L5 discectomy done	Redo discectomy L4L5 level	2 yr	1	43	12	6		6	2	5/5	5/5	5/5	excellent	9 months	-
12	Indira	41/F	78918	L3-L4 L4 L5 disc discectomy and posterior stabilisation done.L1-L2 disc disease	Implant exit and l2 laminectomy and L1 L2 discectomy.	9months	2	74	57	38	23	10	6	5/5	5/5	5/5	good	12 months	Infection ,implant exit
13.	Radha	46/F	8165	L4L5 postdiscectomy instability	Posterior stabilisation L4L5 S1 and posterolateral fusion.	9 months	1	78	41	28	21	8	6	5/5	5/5	5/5	Good	4 yrs	-
14.	maheswari	34/F	5598	Post discectomy L4-L5 ,recurrent disc L4-L5 and instability	L4-L5 discectomy and TLIF	13 yrs	1	72	56			10	8	5/5	5/5	5/5	poor	6 months	Infection,wound wash given
15.	Girija	41/F	35179	Recurrent disc L4-L5 L5S1 level	Laminectomy and discectomy	3 yrs	1	46	40	30	24	10	6	5/5	5/5	5/5	good	3 yrs	-
16	Ayyapan	38/m	55163	L4-L5 discectomy done, epidural scar removal done,with instability.	Posterior stabilisation &posterolateral fusion.	1 yr& 1yr	2	38	26	12	2%	8	2	5/5	5/5	5/5	excellent	5yrs	-
17	Nevilraj	25/m	99443	L4 L5 post discectomy instability	Posterior stabilisation and TLIF	5 yrs	1	58	30	24		6	4	5/5	5/5	5/5	good	8 months	-
18	vasugi	45/f	64988	L5S1 recurrent disc disease	Discectomy	10 yrs	1	45	10	24	44	10	6	5/5	5/5	5/5	fair	4 yrs	-

S. No	Name	Age/sex	Ip. No	Diagnosis	Treatment	Pain Free interval	No. of previous surgeries	Pre op & Follow up ODI score				VAS		Pre-op ASIA score	Post op ASIA score		outcome	Follow up	Complications
								Pre op	6 m	9m	Final				0m	6m			
19	Balakrishnan	23/m	101702/11	L4L5 spondylolisthesis Failed TLIF	Implant exit and redo stabilisation L2L3S1 screws	2 yrs	1	44	10	16	10	8	2	L5-3/5 S1-3/5	L5-4/5 S1-5/5	L5-4/5 S1-5/5	excellent	3 yrs	Dural tear
20	Kannan	55/m	60621/14	L3L4 listhesis posterior stabilisation done with implant failure	Implant exit and redo stabilisation and fusion.	5 yrs	1	54	26			8	6	5/5	5/5	5/5	fair	6 months	infection

Oswestry Low Back Pain Disability Questionnaire

Sources: Fairbank JCT & Pynsent, PB (2000) The Oswestry Disability Index. *Spine*, 25(22):2940-2953.

Davidson M & Keating J (2001) A comparison of five low back disability questionnaires: reliability and responsiveness. *Physical Therapy* 2002;82:8-24.

The Oswestry Disability Index (also known as the Oswestry Low Back Pain Disability Questionnaire) is an extremely important tool that researchers and disability evaluators use to measure a patient's permanent functional disability. The test is considered the 'gold standard' of low back functional outcome tools [1].

Scoring instructions

For each section the total possible score is 5: if the first statement is marked the section score = 0; if the last statement is marked, it = 5. If all 10 sections are completed the score is calculated as follows:

Example: 16 (total scored)

50 (total possible score) x 100 = 32%

If one section is missed or not applicable the score is calculated:

16 (total scored)

45 (total possible score) x 100 = 35.5%

Minimum detectable change (90% confidence): 10% points (change of less than this may be attributable to error in the measurement)

Interpretation of scores

0% to 20%: minimal disability:	The patient can cope with most living activities. Usually no treatment is indicated apart from advice on lifting sitting and exercise.
21%-40%: moderate disability:	The patient experiences more pain and difficulty with sitting, lifting and standing. Travel and social life are more difficult and they may be disabled from work. Personal care, sexual activity and sleeping are not grossly affected and the patient can usually be managed by conservative means.
41%-60%: severe disability:	Pain remains the main problem in this group but activities of daily living are affected. These patients require a detailed investigation.
61%-80%: crippled:	Back pain impinges on all aspects of the patient's life. Positive intervention is required.
81%-100%:	These patients are either bed-bound or exaggerating their symptoms.

Oswestry Low Back Pain Disability Questionnaire

Instructions

This questionnaire has been designed to give us information as to how your back or leg pain is affecting your ability to manage in everyday life. Please answer by checking ONE box in each section for the statement which best applies to you. We realise you may consider that two or more statements in any one section apply but please just shade out the spot that indicates the statement which most clearly describes your problem.

Section 1 – Pain intensity

- ☐ I have no pain at the moment
- ☐ The pain is very mild at the moment
- ☐ The pain is moderate at the moment
- ☐ The pain is fairly severe at the moment
- ☐ The pain is very severe at the moment
- ☐ The pain is the worst imaginable at the moment

Section 2 – Personal care (washing, dressing etc)

- ☐ I can look after myself normally without causing extra pain
- ☐ I can look after myself normally but it causes extra pain
- ☐ It is painful to look after myself and I am slow and careful
- ☐ I need some help but manage most of my personal care
- ☐ I need help every day in most aspects of self-care
- ☐ I do not get dressed, I wash with difficulty and stay in bed

Section 3 – Lifting

- ☐ I can lift heavy weights without extra pain
- ☐ I can lift heavy weights but it gives extra pain
- ☐ Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently placed eg. on a table
- ☐ Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned
- ☐ I can lift very light weights
- ☐ I cannot lift or carry anything at all

Section 4 – Walking*

- ☐ Pain does not prevent me walking any distance
- ☐ Pain prevents me from walking more than 2 kilometres
- ☐ Pain prevents me from walking more than 1 kilometre
- ☐ Pain prevents me from walking more than 500 metres
- ☐ I can only walk using a stick or crutches
- ☐ I am in bed most of the time

Section 5 – Sitting

- ☐ I can sit in any chair as long as I like
- ☐ I can only sit in my favourite chair as long as I like
- ☐ Pain prevents me sitting more than one hour
- ☐ Pain prevents me from sitting more than 30 minutes
- ☐ Pain prevents me from sitting more than 10 minutes
- ☐ Pain prevents me from sitting at all

Section 6 – Standing

- ☐ I can stand as long as I want without extra pain
- ☐ I can stand as long as I want but it gives me extra pain
- ☐ Pain prevents me from standing for more than 1 hour
- ☐ Pain prevents me from standing for more than 3 minutes
- ☐ Pain prevents me from standing for more than 10 minutes
- ☐ Pain prevents me from standing at all

Section 7 – Sleeping

- ☐ My sleep is never disturbed by pain
- ☐ My sleep is occasionally disturbed by pain
- ☐ Because of pain I have less than 6 hours sleep
- ☐ Because of pain I have less than 4 hours sleep
- ☐ Because of pain I have less than 2 hours sleep
- ☐ Pain prevents me from sleeping at all

*Note: Distances of 1 mile, ½ mile and 100 yards have been replaced by metric distances in the Walking section

Section 8 – Sex life (if applicable)

- ☐ My sex life is normal and causes no extra pain
- ☐ My sex life is normal but causes some extra pain
- ☐ My sex life is nearly normal but is very painful
- ☐ My sex life is severely restricted by pain
- ☐ My sex life is nearly absent because of pain
- ☐ Pain prevents any sex life at all

Section 9 – Social life

- ☐ My social life is normal and gives me no extra pain
- ☐ My social life is normal but increases the degree of pain
- ☐ Pain has no significant effect on my social life apart from limiting my more energetic interests eg, sport
- ☐ Pain has restricted my social life and I do not go out as often
- ☐ Pain has restricted my social life to my home
- ☐ I have no social life because of pain

Section 10 – Travelling

- ☐ I can travel anywhere without pain
- ☐ I can travel anywhere but it gives me extra pain
- ☐ Pain is bad but I manage journeys over two hours
- ☐ Pain restricts me to journeys of less than one hour
- ☐ Pain restricts me to short necessary journeys under 30 minutes
- ☐ Pain prevents me from travelling except to receive treatment

.

References

1. Fairbank JC, Pynsent PB. The Oswestry Disability Index. Spine 2000 Nov 15;25(22):2940-52; discussion 52.

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI-3

EC Reg No.ECR/270/Inst./TN/2013
Telephone No. 044 25305301
Fax : 044 25363970

CERTIFICATE OF APPROVAL

To
Dr. R.Neelakannan,
Post Graduate, MS (Orthopaedics),
Institute of Orthopaedics & Traumatology,
Madras Medical College,
Chennai – 600 008.

Dr. R.Neelakannan,

The Institutional Ethics Committee has considered your request and approved your study titled **"A prospective and retrospective analysis of functional outcome of revision lumbar surgery for failed back surgery syndrome"** No.26072014.

The following members of Ethics Committee were present in the meeting held on 01.07.2014 conducted at Madras Medical College, Chennai-3.

1. Dr.C.Rajendran, M.D.,	: Chairperson
2. Dr.R.Vimala, M.D., Dean, MMC, Ch-3	: Deputy Chairperson
3. Prof.B.Kalaiselvi, M.D., Vice-Principal, MMC, Ch-3	: Member Secretary
4. Prof.R.Nandhini, M.D., Inst.of Pharmacology, MMC	: Member
5. Dr.G.Muralidharan, Director Incharge, Inst.of Surgery	: Member
6. Prof.Md.Ali, M.D., D.M., Prof & HOD of MGE, MMC	: Member
7. Prof.K.Ramadevi, Director i/c, Inst.of Biochemistry, MMC	: Member
8. Prof.Saraswathy, M.D., Director, Pathology, MMC, Ch-3	: Member
9. Prof.Tito, M.D., Director i/c, Inst.of Internal Medicine, MMC	: Member
10.Thiru S.Rameshkumar, Administrative Officer	: Lay Person
11.Thiru S.Govindasamy, B.A., B.L.,	: Lawyer
12.Tmt.Arnold Saulina, M.A., MSW.,	: Social Scientist

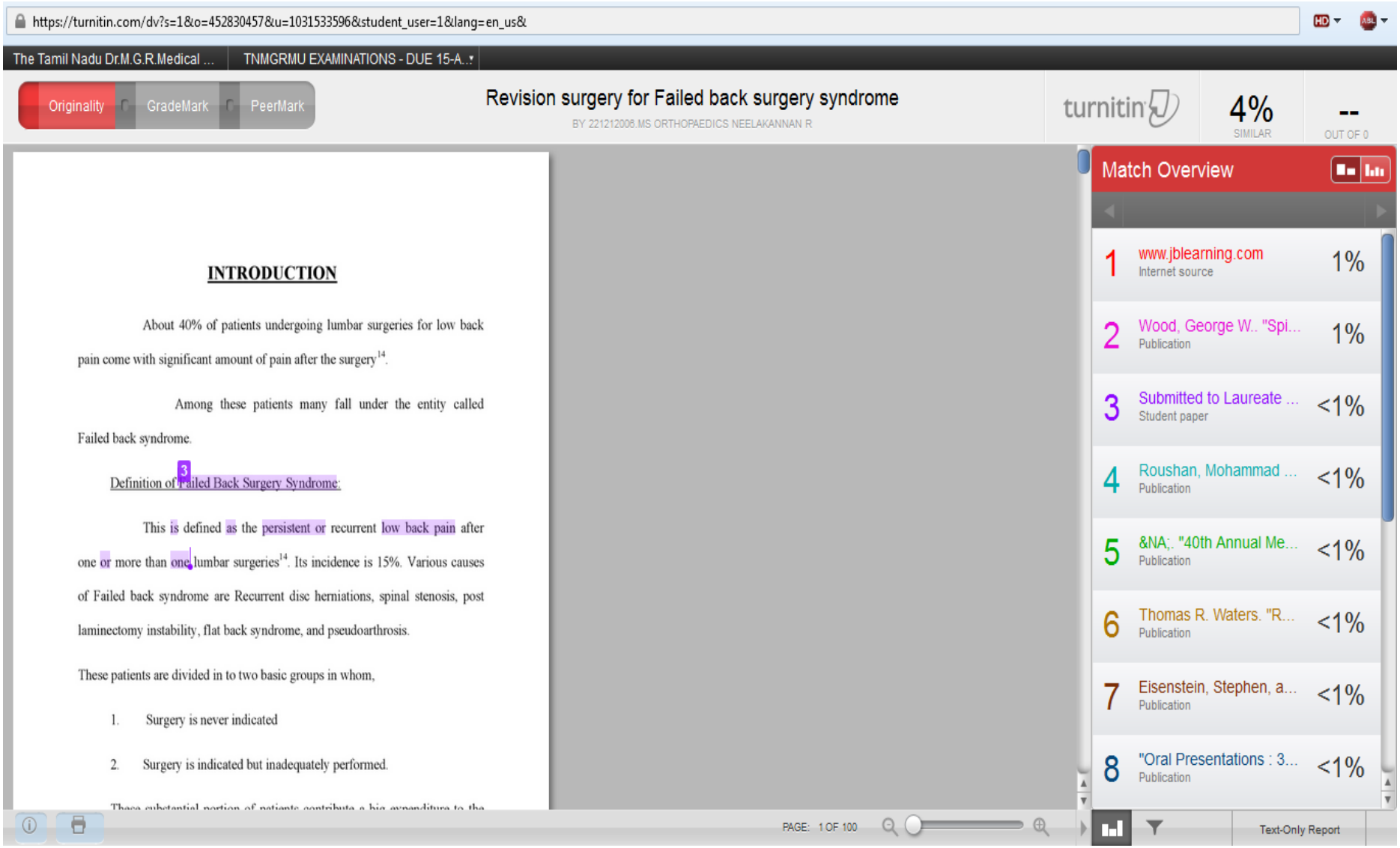
We approve the proposal to be conducted in its presented form.

Sd/ Chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study and SAE occurring in the course of the study, any changes in the protocol and patients information/informed consent and asks to be provided a copy of the final report.

Member Secretary, Ethics Committee

MEMBER SECRETARY
INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE
CHENNAI-600 003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INTRODUCTION
About 40% of patients undergoing lumbar surgeries for low back pain come with significant amount of pain after the surgery[14].
Among these patients many fall under the entity called Failed back syndrome.
Definition of Failed Back Surgery Syndrome:
This is defined as the persistent or recurrent low back pain after one or more than one lumbar surgeries[14]. Its incidence is 15%. Various causes of Failed back syndrome are Recurrent disc herniations, spinal stenosis, post laminectomy instability, flat back syndrome, and pseudoarthrosis.
These patients are divided in to two basic groups in whom,
1. Surgery is never indicated
2. Surgery is indicated but inadequately performed.
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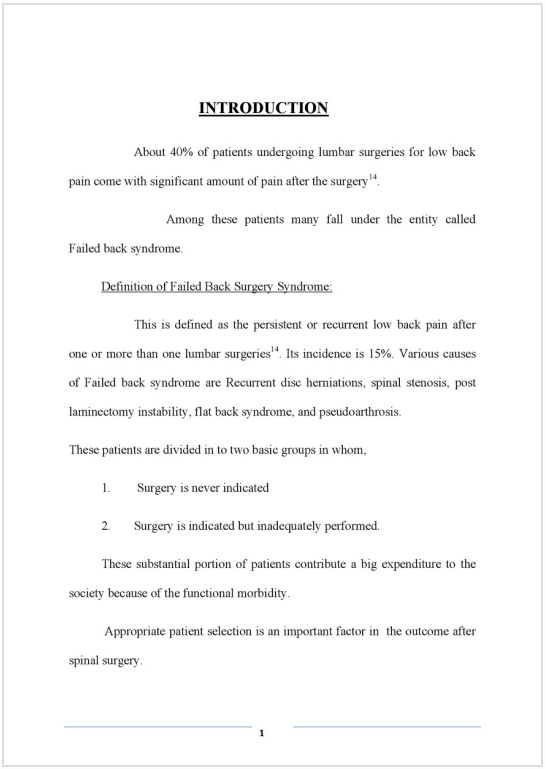

INTRODUCTION

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These patients are divided in to two basic groups in whom,

1. Surgery is never indicated
2. Surgery is indicated but inadequately performed.

These substantial portion of patients contribute a big expenditure to the society because of the functional morbidity.

Appropriate patient selection is an important factor in the outcome after spinal surgery.

1